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THE RELATIONS OF THE UNITED STATES TO THEIR NEW DEPENDENCIES.

By Captain A. T. Mahan.

IN modern times there have been two principal colonizing nations, which not merely have occupied and administered a great trans-marine domain, but have impressed upon it their own identity—the totality of their political and racial characteristics—to a degree that is likely to affect permanently the history of the world at large.

These two nations, it is needless to say, are Great Britain and Spain. Russia, their one competitor, differs from them in that her sustained advance over alien regions is as wholly by land as theirs has been by sea. France and Holland have occupied and administered, and continue to occupy and administer, large extents of territory; but it is scarcely necessary to argue that in neither case has the race possessed the land, nor have the national characteristics been transmitted to the dwellers therein as a whole. They have realized, rather, the idea recently formulated by Mr. Benjamin Kidd for the development of tropical regions,—administration from without.

The unexpected appearance of the United States as the legal owners of trans-marine territory, which as yet they have not had opportunity either to occupy or to administer, coincides in time with the final downfall of Spain's colonial empire, and with a stage in the upward progress of that of Great Britain, so marked, in the contrast it presents to the ruin of Spain, as to compel attention and comparison, with an ultimate purpose to draw therefrom instruction for the United States in the new career forced upon them. The larger colonies of Great Britain are not indeed reaching their majority, for

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that they did long ago; but the idea formulated in the phrase "imperial federation" shows that they, and the mother country herself, have passed through and left behind the epoch when the accepted thought in both was that they should in the end separate, as sons leave the father's roof, to set up each for himself. To that transition phase has succeeded the ideal of partnership, more complex indeed and difficult of attainment, but trebly strong, if realized. The terms of partnership, the share of each member in the burdens and in the profits, present difficulties which will delay, and may prevent, the consummation; time alone can show. The noticeable factor in this change of mind, however, is the affectionate desire manifested by both parent and children to insure the desired end. Between nations long alien we have high warrant for saying that interest alone determines action; but between communities of the same blood, and when the ties of dependence on the one part are still recent, sentiments—love and mutual pride—are powerful, provided there be good cause for them. And good cause there is. Since she lost what is now the United States, Great Britain has become benevolent and beneficent to her colonies.

It is not in colonies only, however, that Great Britain has been beneficent to weaker communities; nor are benevolence and beneficence the only qualities she has shown. She has been strong also; strong in her own interior life, whence all true strength issues; strong in the quality of the men she has sent forth, to colonize and to administer; strong to protect by the arm of her power, by land, and, above all, by sea. The advantage of the latter safeguard is common to all her dependencies; but it is among subject and alien races that her terrestrial energy chiefly manifests itself, to control, to protect, and to elevate. Of these functions, admirably discharged in the main, India and Egypt are the conspicuous illustrations. In them she administers from without, and cannot be said to colonize, for the land was already full.

Conspicuous result constitutes example; for imitation, if honorable; for warning, if shameful. Experience is the great teacher, and is at its best when personal; but in the opening of a career such experience is wanting to the individual, and must be sought in the record of other lives, or of other nations. The United States are just about to enter on a task of government—of administration—over regions which, in inhabitants, in climate, and in political tradition, differ essentially from themselves. What are the conditions of success?

We have the two great examples. Great Britain has been, in the main, and increasingly, beneficent and strong. Spain from the very

first, as the records show, was inhumanly oppressive to the inferior races; and, after her own descendants in the colonies became aliens in habit to the home country, she to them also became tyrannically exacting. But, still more, Spain became weaker and weaker as the years passed, the tyranny of her extortions being partially due to exigencies of her political weakness and to her economical declension. Let us, however, not fail to observe that the beneficence, as well as the strength, of Great Britain has been a matter of growth. She was not always what she now is to the alien subject. There is, therefore, no reason to despair, as some do, that the United States, who share her traditions, can attain her success. The task is novel to us; we may make blunders; but, guided by her experience, we should reach the goal more quickly.

And it is to our interest to do so. Enlightened self-interest demands of us to recognize not merely, and in general, the imminence of the great question of the farther East, which is rising so rapidly before us, but also, specifically, the importance to us of a strong and beneficent occupation of adjacent territory. In the domain of color, black and white are contradictory; but it is not so with self-interest and beneficence in the realm of ideas. This paradox is now too generally accepted for insistence, although in the practical life of States the proper order of the two is too often inverted. But, where the relations are those of trustee to ward, as are those of any State which rules over a weaker community not admitted to the full privileges of home citizenship, the first test to which measures must be brought is the good of the ward. It is the first interest of the guardian, for it concerns his honor. Whatever the part of the United States in the growing conflict of European interests around China and the east, we deal there with equals, and may battle like men; but our new possessions, with their yet minor races, are the objects only of solicitude.

Ideas underlie action. If the paramount idea of beneficence becomes a national conviction, we may stumble and err, we may at times sin, or be betrayed by unworthy representatives; but we shall advance unfailingly. I have been asked to contribute to this discussion something from my own usual point of view; which is, of course, the bearing of sea power upon the security and the progress of nations. Well, one great element of sea power, which, it will be remembered, is commercial before it is military, is that there be territorial bases of action in the regions important to its commerce. That is self-interest. But the history of Spain's decline, and the history of Great Britain's advance,—in the latter of which the stern lesson given by the revolt of the United States is certainly a conspicuous factor, as also, per-

haps, the other revolt known as the Indian Mutiny, in 1857,—alike teach us that territories beyond the sea can be securely held only when the advantage and interests of the inhabitants are the primary object of the administration. The inhabitants may not return love for their benefits,—comprehension or gratitude may fail them; but the sense of duty achieved, and the security of the tenure, are the reward of the ruler.

I have understood also that, through the pages of THE ENGINEERING MAGAZINE, I should speak to the men who stand at the head of the great mechanical industries of the country,—the great inventors and the leaders in home development,—and that they would be willing to hear me. But what can I say to them that they do not know? Their own businesses are beyond my scope and comprehension. The opportunities offered by the new acquisitions of the United States to the pursuits with which they are identified they can understand better than I. Neither is it necessary to say that adequate—nay, great—naval development is a condition of success, although such an assertion is more within my competence, as a student of navies and of history. That form of national strength which is called sea power becomes now doubly incumbent. It is needed not merely for national self-assertion, but for beneficence; to insure to the new subjects of the nation peace and industry, uninterrupted by wars, the great protection against which is preparation—to use that one counsel of Washington's which the anti-imperialist considers to be out of date.

I have therefore but one thing which I have not already often said to offer to such men, who affect these great issues through their own aptitudes and through their far-reaching influence upon public opinion, which they touch through many channels. Sea power, as a national interest, commercial and military, rests not upon fleets only, but also upon local territorial bases in distant commercial regions. It rests upon them most securely when they are extensive, and when they have a numerous population bound to the sovereign country by those ties of interest which rest upon the beneficence of the ruler; of which beneficence power to protect is not the least factor. Mere just dealing and protection, however, do not exhaust the demands of beneficence towards alien subjects, still in race-childhood. The firm, but judicious, remedying of evils, the opportunities for fuller and happier lives, which local industries and local development afford, these also are a part of the duty of the sovereign power. Above all, there must be constant recognition that self-interest and beneficence alike demand that the local welfare be first taken into account. It is possible, of course, that it may at times have to yield to the necessities of the whole body; but it should be first considered.

The task is great; who is sufficient for it? The writer believes firmly in the ultimate power of ideas. Napoleon is reported to have said: "Imagination rules the world." If this be generally so, how much more the true imaginations which are worthy to be called ideas! There is a nobility in man which welcomes the appeal to beneficence. May it find its way quickly now to the heads and hearts of the American people, before less worthy ambitions fill them; and, above all, to the kings of men, in thought and in action, under whose leadership our land makes its giant strides. There is in this no Quixotism. Materially, the interest of the nation is one with its beneficence; but, if the ideas get inverted, and the nation sees in its new responsibilities, first of all, markets and profits, with incidental resultant benefit to the natives, it will go wrong. Through such mistakes Great Britain passed. She lost the United States; she suffered bitter anguish in India; but India and Egypt testify to-day to the nobility of her repentance. Spain repented not. The examples are before us. Which shall we follow?

And is there not a stimulus to our imagination, and to high ambition, to read, as we easily may, how the oppressed have been freed, and the degraded lifted, in India and in Egypt, not only by political sagacity and courage, but by administrative capacity directing the great engineering enterprises, which change the face of a land and increase a hundredfold the opportunities for life and happiness. The profession of the writer, and the subject consequently of most of his writing, stands for organized force, which, if duly developed, is the concrete expression of the nation's strength. But, while he has never concealed his opinion that the endurance of civilization, during a future far beyond our present foresight, depends ultimately upon due organization of force, he has ever held, and striven to say, that such force is but the means to an end, which end is durable peace and progress, and therefore beneficence. The triumphs and the sufferings of the past months have drawn men's eyes to the necessity for increase of force, not merely to sustain over-sea dominion, but also to insure timely use, in action, of the latent military and naval strength which the nation possesses. The speedy and inevitable submission of Spain has demonstrated beyond contradiction the primacy of navies in determining the issue of transmarine wars; for, after Cavité and Santiago had crippled hopelessly the enemy's navy, the end could not be averted, though it might have been postponed. On the other hand, the numerical inadequacy of the troops sent to Santiago, and their apparently inadequate equipment, have shown the necessity for greater and more skilfully organized land forces. The deficiency of the United States in this respect would have permitted a prolonged

resistance by the enemy's army in Cuba,—a course which, though sure to fail, appealed strongly to military punctilio.

These lessons are so obvious that it is not supposable that the national intelligence, which has determined the American demand for the Philippines, can overlook them; certainly not readers of the character of those to whom this magazine goes. But, when all this has been admitted, and provided for, it still remains that force is but the minister under whose guardianship industry does its work and enjoys peaceably the fruits of its labor. To the mechanical industries of the country, in their multifold forms, its new possessions propound the questions, not merely of naval and military protection, but of material development, which, first beneficent to the inhabitants and to the land, gives also, and thereby, those firm foundations of a numerous and contented population, and of ample local resources, upon which alone military power can securely rest.

THE ENGINEER AND THE POLICY OF NATIONAL EXPANSION.

By Charles B. Going.

AN epoch in history creates an epoch in literature. Manila, Omdurman, and Santiago, opening broad opportunities to civilization and industry, open also the era of immensely fuller comprehension of the place and work of the engineer. The literature of his profession must fit the scope of the times.

How wide that scope is, Captain Mahan and Mr. Hunter clearly indicate in these pages—the one writing as the highest authority on national power, the other as a most able practical engineer and exponent of industrial economics. The measure they supply is true, because it compasses the whole front of the progress in which the engineer leads. But the truth is, as yet, hardly recognized and its presentation marks an epoch. The engineer heretofore has been too often regarded exclusively as a technician, and his literature as a specialized department of technology.

The engineer is, indeed, the disciple of an exact science. He deals with principles which are as fixed and all-prevailing as the laws of mathematics—with facts as immutable as the properties of matter. He must be fertile in expedient, widely adaptive in method, resourceful under difficulty—but all these are superficials; the fundamentals of his profession are the same always and everywhere. He rests his work upon the comprehension and mastery of forces which extend throughout the universe—which are uniform, calculable, measurable, definable. And his results are directly creative and visible.

It is, therefore, not surprising, at first sight, that the engineering profession (supposing the average, rather than the exceptional, individual to be the type) should be disposed to regard the problems of social and political economy with indifference, or should be inclined to consider them as wholly foreign to their own *metier* and should look with impatience, or even resentment, upon the attempt to establish an intimate connection between their immediate interests and the seemingly inexact philosophy of sociology and politics.

But engineering science is reasonable, even before it is exact. It must be clear, upon any further thought, that the man whose function it is to work out the material progress of society is not only interested

in, but dependent upon, the solution of every economic problem which that progress presents. His profession is, above all others, a development of civilization. It is, indeed, its material and mechanical side; and, the higher the civilization, the larger his field.

All work depends for its success on two conditions—opportunity and execution. It is a very partial view which includes only the latter and neglects the former. It is an axiom that no engineering work is technically impossible; given the financial support, which constitutes the opportunity, the engineer is equal to the execution of any task—even, as Mr. Gustav Lindenthal lately said in these pages, to bridging the Atlantic. But the same support is as necessary to the simplest task of spanning a highway, and it will not be furnished to the practical man until the financier sees the present stability and future promise which constitute his opportunity.

Capital is proverbially timid. Its timidity, however, is no longer as to the ability of the engineer to plan out an enterprise, calculate its cost, and assure its triumphant completion. The fear is of uncertainty or change in economic legislation, or of disastrous political moves which will unsettle credits, disturb commerce, check industry and subvert social conditions. How can the engineer stand aloof from the things upon which, first of all, not merely the expansion, but the maintenance, of his work depends? The non-material elements (in the physical sense) are the most material to the case. An unstable foundation is much less to be feared than an unstable finance—a shifting channel far less of an obstacle than shifting economic legislation—the confinement of a cramped and difficult tunnel no hindrance in comparison with the limitations of a narrow national policy.

And the engineer's interest is no less than his fitness to participate—and more, to lead—in a wise and far-seeing solution of these questions. His mastery of the direction of physical forces carries him a long way toward the comprehension of the kindred economic forces. His whole training and practice cultivate his power to discern the actual through the superficial—to shape the present action to the ultimate, though yet unseen, end—to plan out the uncreated structure and build steadily and consistently toward it, foreseeing difficulties and needs and providing to meet them as they arise. His foresight commands the respect and trust of those who consult and retain him. His manifested skill and ability hold the confidence of those who work with and under him. He is a natural leader, and duty, qualification, and interest conjoin to call him to the widest sphere of influence and administration. So far as internal affairs are concerned, it is neither expedient nor, in his own interest, possible that his work and thought should be confined to the development and

utilization of natural resources—to the opening of mines, building of roads and transportation systems, erecting houses and industrial establishments, providing for the health, comfort, and luxury of the people. All these things depend upon a stable social system, a sound industrial policy, and a constantly-widening development of the means of securing work and wealth. The tariff and currency, economic and corporate legislation, forestry and mining law, individualism and socialism—are prime factors, least of all to be ignored by the engineer or excluded from his discussion and his reading.

The engineer is no mere technician; he is the moving spirit in all material advance. His connection with all the affairs of life—private, corporate, municipal, national—grows daily wider and more intimate. To him is due the steady and rapid rise in the standard of living, the gain in security and comfort of the individual, the vast increase in production. With better sanitation, safer travel, more secure residence, and the other concomitants of progressive civilization, population is increasing at an accelerated ratio, and new problems arise.

Already some gloomy forebodings are advanced as to the exhaustion of the means of existence. The fear is far off, but the immediate logic dictates a more effective use of the wealth of the world by freer intercommunication and by fuller development of the most backward and least-contributing portions. And the most significant movement of the times is the infusion of occidental life, and especially of Anglo-Saxon vitality, into long-dormant countries.

In the new gospel of industrial awakening, the engineer is the missionary. The mechanic, not the farmer, is the modern pioneer. The hammer leads the plough into the wilderness.

Witness the march of the railway and the telegraph through the length of Africa; the extension of the line across the continent of Asia; the opening of the electrical age in Japan.

But it is not the pioneer engineer alone who reaps a reward. The introduction of civilized living, stable and honest government, and wealth-making power bring enormous benefits to the new land, and at the same time afford enormous markets, with all the advantages they imply, to the home country. Precisely the same thing is true, and preëminently so, within the engineering profession.

The majority can not, or will not, expatriate themselves; but the pioneering minority first reduce the pressure of over-competition for the home places, and next create applications for products which stimulate, to their full capacity, the domestic industries. Ships must be built, railways constructed and equipped, electric-light and -power plants provided, manufacturing and mining installations designed and prepared, structural materials exported. And the practice in the

newly-developing country, and the placing of the orders for its supplies, will be governed largely by considerations of national influence and affiliation. These are matters the engineer can not afford to ignore, whether or not he ever leaves his home.

Industrial ascendency, not political power, is the animus of modern international struggles. To the barbarous idea of depleting new territory has succeeded the immensely higher and more fruitful one of enriching it, by inspiring self-cultivation, with enormous reactive benefits to the parent or protecting nation. Co-operation, not tribute, is the new conception, as much more profitable eventually as it is more moral. The statesman who directs policies, and the military leader who protects the peace and maintains the order under which alone industry can be established and bear fruit, have thus become servants and ministers of the engineer who carries on the actual wealth-making work. He is far more than an interested spectator. He is the principal whose interests are at stake. The machinery and methods of war, which he has revolutionized, have now, as their chief function, his protection in the cultivation of the productiveness of peace.

"National expansion" would be a meaningless watchword if it meant only the enlargement of territory; its significance lies in the sure enlargement of markets and the increased demand for industrial manufactures and engineering talent which have more direct, practical significance than any technical discussion. "Imperialism," as a shibboleth of aggrandized political power, might well excite opposition; its true meaning—the helpful federation of the colonies which need manufactures with the strong power which has them in abundance to supply, and with them the strong arm to protect the rising commerce—must enlist the interest and sympathy of everyone even remotely connected with engineering industries. The struggle for the "open door" would be worse than futile, if it were not for the trade which is to flow through it, enriching those who sell, those who buy, and even more surely those who plan, direct, and manage the great manufacturing establishments.

The age of military aggression is disappearing, and the engineer, no less than the statesman and the soldier, must change his functions with the times. As the diplomat is becoming more of a commercial agent, and the commander more an administrator of order than a maker of war, the engineer must advance to a more influential place in the shaping of the policies under which the productive power of the country can be most surely and steadily increased and the largest returns be secured for the worker and the leader of industry.

It is, after all, but an expansion of his functions, not a new de-

parture. As a consultant in work involving large capital outlay, matters of finance come properly within his scope. He must be familiar with their bearings and with the influences which affect investors favorably or adversely. He is frequently called upon to remain and administer the great undertakings he has created, to pass from the technical to the commercial management of vast enterprises, and to witness the economic effects and influences of works which are well-nigh national in their scope. His whole training and habit lift him above bias or prejudice, fit him to balance fact with fact, to eliminate non-essentials, to draw correct conclusions, and to see the consequences from the premises.

He is accustomed to see long perspectives and wide horizons. Above all, his profession qualifies him to measure the intervening difficulty against the potential result, and out of the confusion of the present to foreshadow the completeness and order of the future.

The times are moving rapidly, and upon the events of the next few years—or even months—depend consequences of enduring importance to the entire world. To Germany, England, and the United States especially is the importance supreme. They stand as the three great industrial countries whose products are preëminently such as the whole world needs, and whose productive capacity is greater than their home consumption can absorb. Russia is herself an undeveloped country, needing imports rather than ready to offer exports. France has few manufactures suited to new lands.

In the great game of international politics, upon which the opening and enlightenment of so large a portion of the earth's surface depend, the engineer has more at stake than any other man living. The discussion of the great questions it presents,—the broad view of economic conditions and industrial equipment in the principal nations which may compete, but must co-operate, in the industrial awakening of the East, and the study of every politico-economical problem at home,—far from being foreign to him, is vital and essential.

Practice, on its technical side, is established and formulated. Study is by no means thereby excluded; the strenuous competition of the day demands close attention to improvement of processes, reduction of costs, and betterment of design and construction. But to this narrower, though essential, economy must be added that wider economy which realizes that the world was a workshop before it was a battlefield, and will be a workshop when the battlefield is forgotten. Nothing in the government or policy of this vast workshop is of less than extreme importance to the worker,—above all to the engineer who to-day stands first in peace, first in war, and foremost of all in

his part in the maintenance and advancement of the whole human race.

"Nations, like men, are governed by their interests." These interests, wisely understood, are ably presented by Captain Mahan. They are the maintenance of peace, the extension of just and stable government, and freedom of commerce. The work which England has done in Egypt, India, and Africa has been of inestimable benefit to the world. Germany and the United States are aroused to the same sense, and all must stand together for the policy of beneficence and progress. The leaders of finance and industry realize it, and no ruler or government dares to ignore their voice in a craving for political power or military glory.

But capital works through industry. The first and the greatest reward, the closest and largest interest, are those of the engineer.

THE FIGHTING ENGINEERS AT SANTIAGO.

By Arthur Warren.

ALL war correspondents are not immune. Their susceptibility to the fever of excitement may be a qualification.

One of the feverish accounts of the sinking of Cervera's fleet began: "As the smoke from the Spanish vessels rose from behind the hills at the narrow entrance of Santiago harbor, a hurried signal from the Brooklyn was followed by a rush of the American crews to the winches, and then all the Yankee ships weighed anchor and started full-speed after the enemy."

The account was possibly graphic, but it was not true. The crews did not rush to the winches, because they were not ordered to do so; there would have been no object. The ships did not weigh anchor, because in weeks they had not dropped an anchor. They did not start at full speed, because they were not in condition.

On a modern warship all the facts of a fight are not to be seen from the bridge. There are important facts which lurk in what the word-mongers call "the bowels of the ship." Some news seekers appear inclined to think that on the bridge and in the cabin of the commander they will find the fountains of all knowledge. Besides, it is pleasanter there than in the depths. How was it that the correspondents at Santiago omitted to mention a fact no less important than this,—that on that Sunday morning when the Spanish fleet broke out from the harbor of Santiago the American fleet was unprepared to make a quick movement of any kind in the face of the enemy?

For the navy the war with Spain in American waters was an engineers' war. "The man behind the gun" gave splendid service,—none better,—and won glory for it. So much praise was used up on him that the supply was inadequate for distribution among all branches of the navy. Jackie deserved his honors. But even American warships do not move by wishing or by gun-fire. The engineers put the ships where "the man behind the gun" could give an account of himself. Admirals and captains are brave enough, and keen tacticians, no doubt, but the best part of the Spanish fleet would have slipped through somebody's fingers that Sunday morning at Santiago if America's fighting engineers had not, by the hardest of work, overcome the obstacles imposed upon them by orders from the bridge. If the fighting had been against men more nearly kin—say English or German—under conditions identical with those off Santiago on the morning of July 3, some American hulks might now be rusting at the bottom of tropic seas. For engines were uncoupled, and many

fires out, and steam so low that all the energy of the stokers was required to get it up again.

The American ships had been off the coast for weeks, waiting for the enemy to come out. When the enemy came out, the American ships were ready to shoot, but not to give chase. This was no fault of the engineers. It was not the effect of over-confidence. It was the result of a condition. The condition is peculiar to naval practice. It was long ago discarded in the merchant service. In the merchant service a chief engineer controls his department. In the navy the captain controls the engineers, and is in turn controlled by the commanding officer of the fleet. The chief engineer of an Atlantic liner looks to his captain for starting and stopping signals only; for the rest, he takes his orders from his owners, and reports to them. The chief engineer alone is responsible for the care, operation, and economy of the machinery. In the navy the ship's captain decides how many boilers shall be used, how much coal shall be burned, what pressure shall be carried. And the American captains at Santiago had everything in readiness, except their boilers and engines. There were two exceptions,—the Oregon and the Gloucester.

The whole world, not excepting the Spanish officers, has praised the Oregon's wonderful work — cruising and fighting. What the Oregon did other American ships could do with similar men. The Oregon's record is a tribute to the fighting engineers. It is a tribute to the good sense of the commanding officer who permitted his chief engineer to control the engines. It is a tribute to the engineer-in chief of the navy, Commodore Melville, who designed the engines. It shows the relation of the engineer to modern sea-fighting.

From Bremerton, on Puget sound, to Jupiter inlet, on the Florida coast, is 14,500 nautical miles. The Oregon steamed this distance in 1,299 hours, including stops for orders and coal; she burned 4,009 tons of coal; her highest speed was 14.6 knots, her lowest 10.159, her average 11.16. For the most part she suited her pace to that of the little Marietta, which she convoyed. She arrived at her journey's end, joined the blockade, and entered the fight without having to make a requisition for repairs.

Eternal vigilance is the price of good engines. Robert Milligan, fighting engineer, and the men under him put the Oregon where the men behind the guns could destroy the best ships of Spain. The Oregon started down the Pacific without a wartime complement of men—27 short in the engineer's force, and 67 less than her builders furnished on her trial trip. This meant work for the 94 who had to steam her to Jupiter inlet. When the ship stopped at San Francisco, at Callao, at Port Tamar, at Punta Arenas, at Rio, at Bahia, at Bar-

From Photo, Copyright 1898, by Wm. H. Rau, Philadelphia.

U. S. S. OREGON.

10,231 TONS, 5000 I. H. P.; 348 x 69.3 x 24 FT.

Twin screws; two sets triple-expansion engines; four horizontal return-tubular and two auxiliary single-ended boilers; sixteen furnaces; coal capacity, 16,000 miles at 10 knots. Four 13-inch B. L. R. in pairs in turrets; eight 8-inch B. L. R. in pairs in turrets, two on each beam; four 6-inch Q. F. R. in sponsons; twenty 6-pdr. Q. F.; six 1-pdr. Q. F.; four Gatlings; seven torpedo-tubes.

CAPTAIN CLARK, U. S. N., COMMANDING U. S. S. OREGON AT SANTIAGO.

badoes, they worked all the harder, for there was coaling to be done, and overhauling in careful haste. When the coaling was specially rapid, the officers and men of the engineer's force worked twenty-four hours on end, overhauling and adjusting, so that no minute was lost. The ship started when the bunkers were filled. There was never a minute's delay. All the cruise through, there was unremitting care. If a joint weeped, it was tightened on the instant. In the straits of Magellan the men wanted to try the forced draught. That fact is proof of their spirit. Forced-draught practice answers to General

Sherman's description of war. It is hell. Every ship in the United States service is supposed by the regulations to have a forced-draught test twice a year. Only the commander of the ship can order it. But some of the ships have never made a forced draught run since their trial trips. Perhaps the captains do not believe in it. At any rate, their men have not been trained to use it in emergency.

Milligan declined to ask the captain for permission to use forced draught. He knew that his short-handed crew were working hard enough, and half their work was still before them, and a fight at the

CHIEF ENGINEER MILLIGAN, U. S. S. OREGON.

end of it. Or the fight might come any day. But the men had caught the spirit of their chief; their pride was to keep everything in readiness. The difficulty was not to get them to work, but to prevent them from overworking. When the chief saw that they really wanted to try forced draught for the ship's sake, he persuaded the captain to let them do it. It was to them what gun-drill is to the men on the deck and in the turret. So they did it, and they did it again, and at Santiago they handled the forced draught like a plaything.

Not an ounce of salt water was allowed in the Oregon's boilers. Milligan, writing from Callao to a brother officer, said: "I fear that I am rapidly becoming the most unpopular man in the ship, because I am determined that we shall not put salt water in the boilers, and to that end have insisted to the captain that, if necessary, we must cut down the fresh water allowance for officers and men to the bare amount necessary for drinking and cooking, using salt water for bathing and all other purposes."

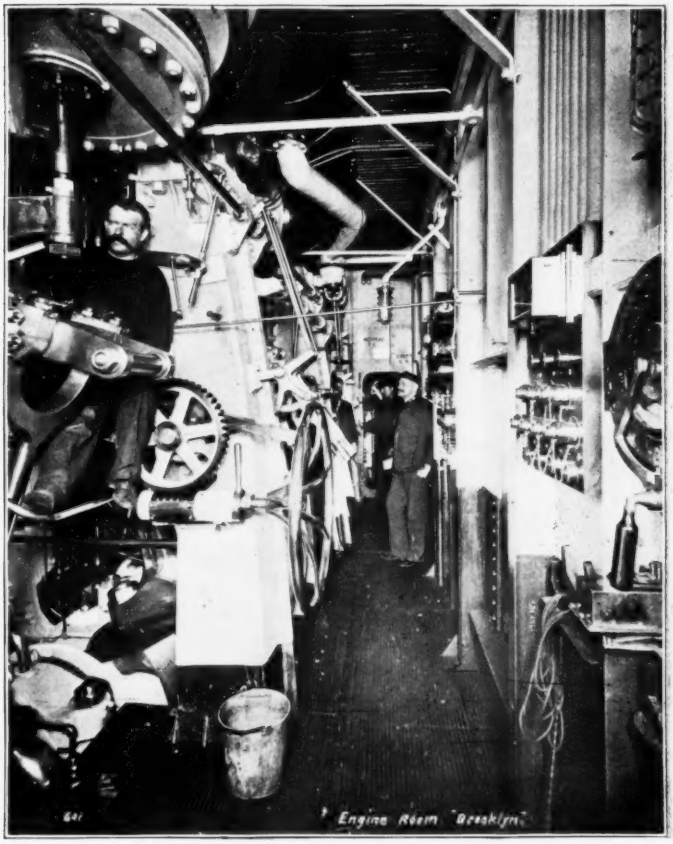
The lay mind might suppose that the object of sending the fleet to Santiago was to have it ready to jump at the enemy at the sound of the general alarm. There is a touch of the farcical in building warships, equipping them with powerful machinery, to be able, at the instant of battle, to get out of them only a fraction of their power. But somebody in authority reasoned in the fashion of Gilbertian topsy-turveydom. So the American fleet waited for the Spaniards with engines uncoupled, boilers filled (as they had long been) with salt water when they were not empty, and half the grates as clean as whistles and as cold as ice boxes.

"On the fighting ship the fighting man must stand supreme," said Theodore Roosevelt, when he was assistant secretary of the United States navy. And then he shrewdly added: "Only he must know how to handle his tools, and must change as the ship changes, so that, precisely as he once knew about sails, now he must know about engines. There can be no divided command. Only one man can exercise it; but he must be thoroughly fitted for it."

"We were caught unprepared," said one of the United States engineers at Santiago; "low fires in three boilers, others empty, and furnaces not charged."

Then there was the Brooklyn. She had five double-ended and two single-ended boilers, the equivalent of six double-ended boilers, in three water-tight compartments. She steamed from Hampton Roads to the south coast of Cuba, *via* Key West, using four boilers and four engines over the entire distance.

The commodore or the captain always designated the number of boilers and engines to be used on the Brooklyn. In practice it took



THE ENGINE ROOM OF THE U. S. BROOKLYN.

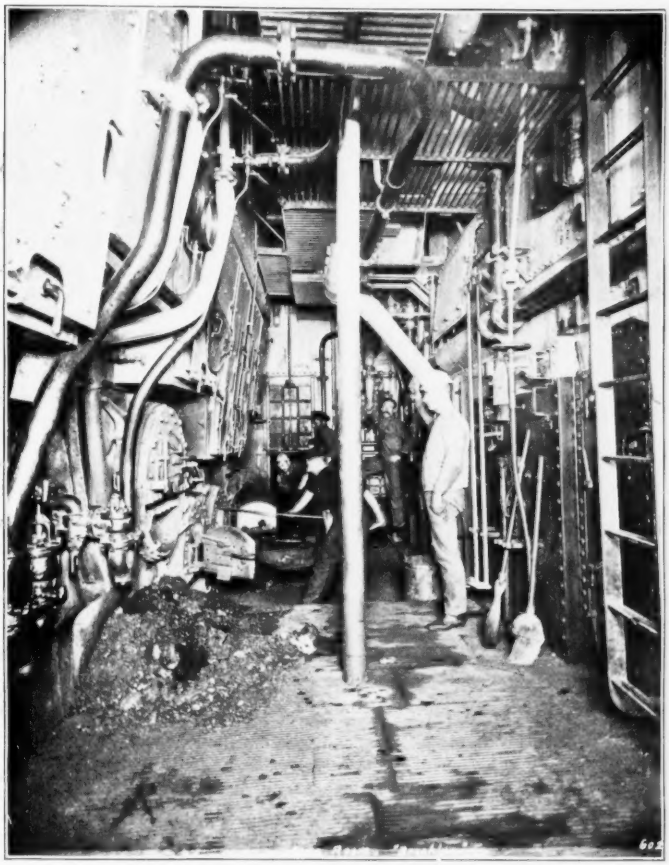
half an hour or more to couple the forward pair to the after pair of engines, and nearly an hour to uncouple them. There are no friction brakes fitted to the Brooklyn's propeller shafts, as in the case of the triple-screw cruisers; so, aboard the flagship of the "Flying Squadron," it was necessary, when coupling up the forward engines, to stop one after engine and run the other slowly for half an hour or longer, and then repeat the operation on the other side of the ship. There was another way to do it; they could stop both port and starboard engines, and then couple up!

P. A. ENGR. T. F. CARTER,
U. S. S. Brooklyn.

When there was no enemy anywhere about,—on the way from Hampton Roads to Santiago,—the flagship of the United States "Flying Squadron" had all her engines and four of her boilers in use. When she went on the blockade at Santiago, and had the enemy in touch, the flagship of the "Flying Squadron" had only half her engine power and half her boiler power ready for use. Did the bridge expect the enemy to signal: "Please connect your engines and boilers, and be good enough to light your fires. I am coming out!" Admiral Cervera was polite enough to pay the Brooklyn the compliment of his best intentions. He acknowledges that he thought her the fastest of the United States ships, and that his hope was to disable, or sink, her. Admiral Schley (commodore, as he then was) turned his ship to starboard, swung to the south, and ran seawards before taking up a parallel course with the now-retreating Spaniards. Schley is reported to have turned his ship, in order to avoid being rammed. It might be asked why he didn't do the ramming himself. But, if he had desired to do it, and if his ship had been built for it, he couldn't have managed it with only half his engine power. He had steam only in three boilers; of his remaining boilers some had water, others were empty. The interesting manœuvres of the Brooklyn will be none the less interesting, if it is found, on investigation, that standing orders from the bridge to the engine room had deprived the ship of so much of her power that she had to turn on her heel and keep at a respectful distance from the Spaniard.

After the general alarm was sounded, there was nothing for it but to fill the Brooklyn's empty boilers with sea water. Then the fires had to be laid and started. Just before the Colon surrendered,—that is, just at the end of the battle,—all the Brooklyn's boilers were steaming at maximum pressure. But the forward engines were, of course, uncoupled still. There had been no time to stop, or to slow up. The engineers had their hands full with the job of shoving the ship after the Spaniard, then pulling her away from him, and then running

with him so that the man behind the gun could pump shells into him. The Brooklyn's actual running time over the 45 miles from Morro to the stranded Colon was 3 hours and 19 minutes,—a speed of 13.06



THE FIRE ROOM OF THE U. S. S. BROOKLYN.

knots. And her rated speed under natural draught full power is 18 knots; under forced draught, 22 knots.

But the Brooklyn was not the only ship caught unawares on that hustling Sunday morning off Santiago bay. Sampson's flagship, the New York, was one of the lame ducks of the fleet. The trifling dis-

tance between her eastward position and the line of the dash of Cervera was not what kept her out of the battle. Her forward engines, by orders from the bridge, were disconnected. There were boilers disconnected, empty, and, of course, fireless. Three hours after the New York started on the westward chase she had steam in all her boilers. Her engines are like those in the Brooklyn. Their condition at half-past nine that Sunday morning was precisely similar. The New York's running time, 45 miles from the Morro to the Colon, was 4 hours and 8 minutes,—a speed of 11.06 knots. Her rated speed under natural draught full power is 16 to 17 knots; under forced draught, 21 knots.

When the flagships set such seamanlike, workmanlike, fighting examples, what can be expected from the rest of the fleet? Chiefly, at the last minute, dependence on the fighting engineers to overcome needless obstacles, put the ships into position, and hold them there.

Until that morning the Brooklyn had never been under forced draught since her contract trial-trip. I have said that the service regulations require forced-draught trials at least twice a year. The regulations also provide that forced draught shall never be used, except by order of the commanding officer.

The Iowa, under orders to carry steam enough to give a seven-knot speed at night and a five-knot speed by day, was bent chiefly on coal economy. The Oregon passed her like a racer. Perhaps that is why the Oregon's erratic chaplain thought the Iowa was going in the opposite direction. The Indiana was more completely unprepared than the Brooklyn, if possible; as elaborately so as the Iowa.

The torpedo boats had a hard time in the Spanish-American war. Officers who were on them, and officers who were not on them, but who know the facts, tell truths unfamiliar to the popular ear. At the outbreak of war the number of engineer officers in the United States navy was so ridiculously inadequate to the duties required that the navy department was compelled to experiment at running torpedo flotillas with a single engineer. Not one engineer to a boat, but one engineer to six or eight boats! Young line officers had to look after the engines in the intervals of their other duties. They are not to be blamed for the defective results. They were faithful enough and ambitious enough, but you cannot learn engineering in three months.

Some of the United States torpedo-boat boilers were completely wrecked for lack of water. One of the boats burned all her boilers so badly that, when they were taken out, the workmen, the contractors, inspectors, and everybody else who saw them, were amazed at the temerity of the men who had kept steam in them. The commanding officer of one torpedo boat prepared an elaborate report on

CHIEF ENGINEER W. B. BAYLEY,
U. S. S. Massachusetts.

the constructive defects of the machinery of his craft. A judicious friend pointed out that his report really proved the mishaps in his engine-room to be due to the inexperience of the men who had been allotted to duty there.

The Oregon was not favored by position at half-past nine that Sunday morning off Santiago. She was, if anything, farther from the harbor entrance and the course of the Spaniards than the other battleships, but in the long chase her shells told the Colon that the game was up. The Colon, in spite of her poor mechanical condition, was nearly holding her own with the Brooklyn. But the Oregon, nominally of five knots' less speed, was steadily gaining. Milligan's work brought the ship into position where the man behind the gun could use his biggest armament. The Oregon was running at a rate exceeding sixteen knots. Her shots sent the Viscaya to the shore in flames. Her thirteen-inch shells compelled the Colon to surrender. Every official report paid tribute to her work. It is even officially conceded that, but for the Oregon, the Colon and probably another Spanish ship would have escaped. So much for having engines in order, boilers ready, fires burning. Here was a ship after a fifteen-thousand-mile run, four months out of dock, with foul bottom and increased displacement, almost equalling her trial-trip record for speed. And she fought as she ran. Inside of fifteen minutes after the full-speed signal was given, she was making fifteen knots. Within an hour she was making nearly seventeen.

Coming down the Pacific, the Oregon had Cardiff coal under her boilers,—the best quality of Cardiff for steaming. When she turned the corner of the continent and got into the Atlantic, she picked up in the coal-ports the best fuel she could buy, but it was much inferior to Cardiff. Milligan had a few hundred tons of Cardiff left. He shovelled them into the fighting bunkers. "This will do for emergency," said he. Then he locked the bunkers. On the blockade the coal supplied to the ships was—well, less fiery than patriotism.

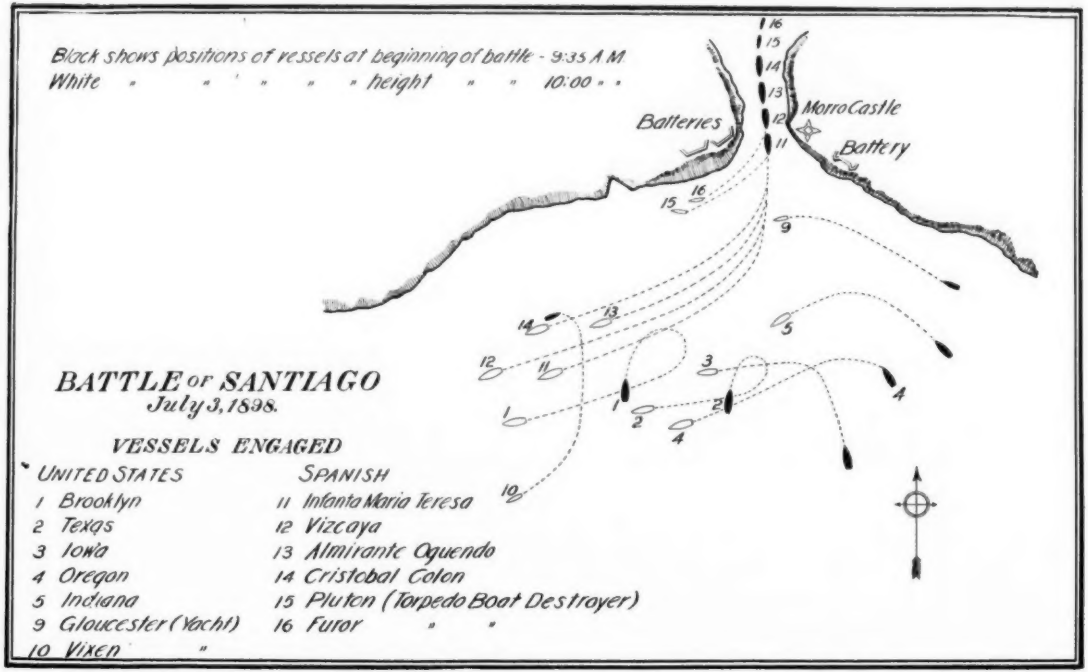


CHART SHOWING THE POSITIONS OF SPANISH AND AMERICAN VESSELS AND THEIR MOVEMENTS AT THE BEGINNING OF THE ENGAGEMENT OF SANTIAGO, JULY 3, 1898.

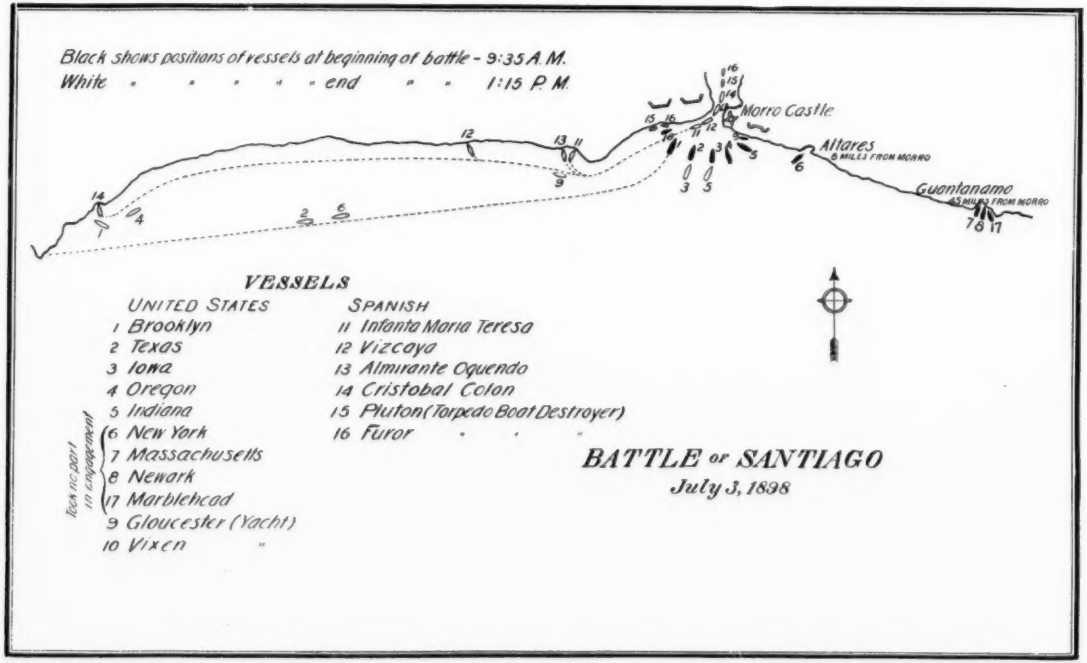


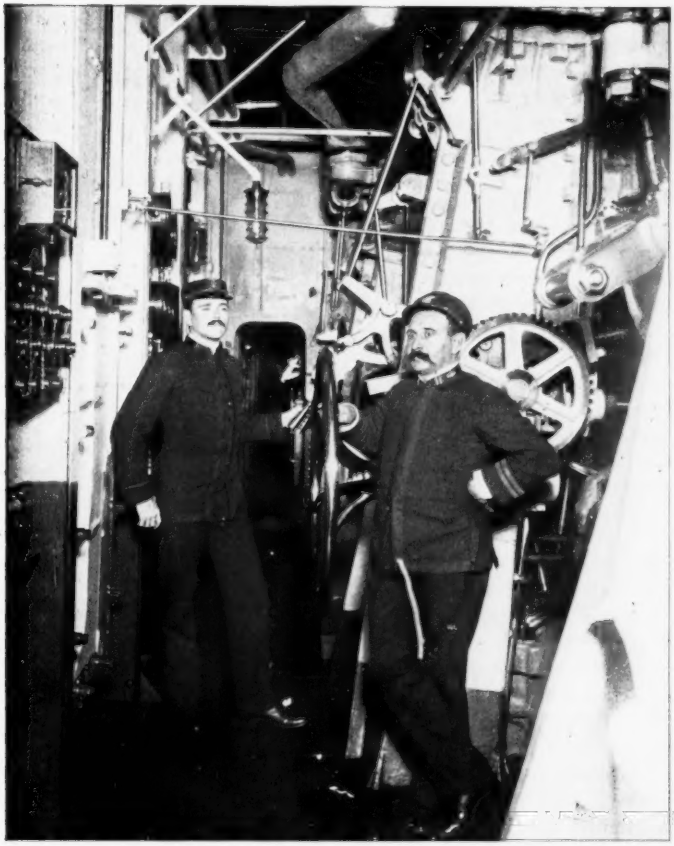
CHART SHOWING POSITIONS OF SPANISH AND AMERICAN VESSELS AT THE BEGINNING AND THE END OF THE BATTLE OF SANTIAGO.

CHIEF ENGINEER CHAS. W. RAE, U. S. N.
U. S. S. Iowa.

On the day of the battle Milligan unlocked the fighting bunkers, and the Cardiff coal helped the Oregon to make her burst of speed. Besides, there were fires under all her boilers when Cervera slipped out. "For God's sake, get on more boilers!" That was the sort of message sent from the bridge of one of the United States warships to the chief engineer, half a dozen times in an hour, when the fleet was pelting the Spaniards. The authority who in time of war had his boiler-rooms ready for peace chafed at the delay. His anxious messages were beginning to worry the men below—machinists, water-tenders, oilers, coal passers, firemen. The chief engineer stood in between, knowing that his men must keep cool-headed, and he sent back word that all the boilers were connected, filled, and all the fires burning. "It's the only way to keep the old man quiet," he said. But all the boilers were not yet connected when the fight finished.

If you were sealed up in a heated iron tank floating on the sea and hammered at by missiles which now and then let in daylight and splinters, you would get a dim idea of the lot of the engineer's men aboard a battleship in action. But the engineer's men have to work in the hurly-burly, and you would go mad in your tank. The enemy's shot pounds the ship, but the engineer and his men know not where the enemy is or where the ship is heading. And they can't stop to think about it. Keep that bearing cool, smother it in oil, drown it in water! Keep it cool, or the game's up!

P. A. ENGR. F. M. BENNETT.
U. S. S. New York.



IN THE ENGINE ROOM OF THE U. S. S. IOWA.

The men on deck can let the splinters lie where they fall, but the men in the engine room have to keep the splinters out of the machinery. Steam pipes are pierced. Mend 'em. Crawl behind the boilers, and stop that steam leak. Impossible to shut off anything. Scalded? Never mind. It's all in the day's work. Don't let the water down. Pass the coal lively. And, while you're about it, put out that fire in the bunkers. Grimy men, dripping with sweat, go about quietly, with clear heads, watching everything. There's no bawling, no usual noise, no confusion. In the lower engine-rooms the thermometer

shows 136 degrees in front of the ventilating blowers; in the upper engine-rooms, 190 degrees. Men dart into the upper rooms twice an hour or so, look around for a minute or two, and then dart out again. There on the hot seas, on July 3d, the temperature above the boilers of the Texas was sometimes 200 degrees!

The fighting engineers! By old-time tradition, dating from the days when steam power was merely an auxiliary to wind power, the naval engineers are thought of as non-combatants. Ships change, and duties change. The engineer is now a combatant as truly as the man on the bridge or the man behind the gun. The modern fighting ship is a fighting machine; her efficiency depends upon the engineer.

CHIEF ENGINEER E. R. FREEMAN, U. S. N.
Formerly of the Nashville; now of the Indiana.

The engineer of the merchant service has authority which the naval engineer does not possess. It is now proposed, in the United States navy, to improve on the practice of the merchant service. Enlightened opinion favors the plan for abolishing the distinction between line and staff. Engineer officers are to be officers of the line. All line officers are to be taught engineering.

A generation hence the anomalies of the present service will have passed away. The line officer of the future will know the engine room as well as the wheel-house and the bridge, for he will serve below as well as above. Meanwhile nothing will be lost, if we remember what the fighting engineers did to save the day at Santiago.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

SPECIALIZATION VS. GENERALIZATION OF EQUIPMENT AND PRODUCTS.

THE large quantity of American machinery now being sent to European countries indicates that there is something in American machine-tool practice and design which is desirable to European manufacturers, and cannot be secured from their own makers of machinery. Why is it that the European manufacturer is buying so largely from America? How is it that the American machine-tool maker can send machinery abroad, pay freight and duty, and compete with the European maker? It is important for both sides to understand the situation: on the one hand, for the European to select that which is good in American practice, and to adopt it as far as possible; on the other hand, for the American maker of machinery to know where his practice differs from the European, so that he may adapt his methods, as far as desirable, to European demands. An attempt will be made in this and following articles to review the situation from an impartial standpoint, not to criticise one side or to unduly praise the other, but to state facts which may be of interest to both. Having had nine years' experience among European manufacturers, I do not hesitate to state that not one manufacturing establishment among ten, in either England or Germany, is properly equipped with machinery, or organized in accordance with modern methods. With exceptional opportunities for coming in contact with makers and dealers in American machinery, I have found few who understand the requirements and conditions of European manufacturers.

A word should be said here as to the importance of the "machine tool" in its relation to general manufacture, and to the place it occupies as a factor of industrial progress. It is the mother of all modern industries. Without it, interchangeable work, and the manufacture and maintenance of automatic machinery, are impossibilities. Without the backing of highly-skilled mechanics, who are developing and making efficient and accurate machine tools, the manufacturers of the United States could not hold the position they do,—a position which justifies the following statement of a leading London daily: "There is no question that the commercial interests of the United States are growing by leaps and bounds. Europe is

beginning to be inundated with American goods, and American firms are getting contracts at the expense of European rivals all the world over." This could not be accomplished except for the fact that American manufacturing plants are maintained by the universal use of high-class machine tools operated by well-paid workmen—workmen who receive wages that are invariably considered by European manufacturers wasteful and ridiculously in excess; nevertheless, these wages are as much a necessity in Europe as in America,—perhaps more. European manufacturers do not, as a rule, appreciate the fact that high-class and accurate machine tools are necessary auxiliaries to economic production, and that, in selecting them, quality should be the first consideration. Want of understanding in this respect, on the part of both employers and employees, is one of the most serious drawbacks to progress among European manufacturers. The accurate machine tool is the stronghold of the American manufacturer. How it is made use of by the one, and neglected by the other, it is my object to explain.

In treating the subject, it will be recognised that there are exceptional cases, good and bad, in all countries. As far as American practice is concerned, special reference is made to the New England States, the acknowledged home of American machine-tool design. Among European countries, England and Germany are particularly referred to, as they are, at present, the most important to the general machine-tool market.

A modern machine shop is made up essentially of four elements:

(1) The factory organization;
(2) The equipment;
(3) The workmen;
(4) The commercial management.

In comparing European and American machine-shop methods, however, there are certain peculiarities which call for special consideration, and the above items must be sub-divided. For clearness and convenience, it is thought best to treat the matter under the following headings, which, as will be noted, include the above:

(1) Specialization and manufacturing varieties;
(2) Labor-saving machinery and low-wage workers;
(3) Environment and efficiency of workmen;
(4) Commercial conditions;
(5) Elements of a modern machine shop;
(6) Comparisons as to efficiency of machinery and methods.

To an American manufacturer visiting European machine shops, the most striking thing is the immense variety of work turned out by establishments of any size whatever. He is invariably astonished at

the variety of work undertaken, even by small shops,—a variety rarely attempted by any American establishment. There are many machine shops, both in England and on the continent, that will supply complete plants of machinery, and manufacture within their own walls boilers, engines, shafting, hangers, pulleys, small tools, and all sorts of machines, both large and small. While this state of affairs may be explained historically, it cannot be defended as an economic principle, in the light of modern practice. The very opposite policy is followed by most American makers of machinery. Many concerns could be mentioned which devote themselves entirely to one line of machinery, and have no hesitation whatever in refusing business or orders for anything which they are not specially equipped for producing, and of which they have not made a special study. In a number of cases this is carried to the extreme. One firm makes nothing but turret lathes, and only one size at that. Others confine themselves wholly to the manufacture of drilling machines, or of lathes, planers, milling machines, grinding machines, etc. In fact, in America every article in the list of machine tools is receiving particular attention from specialists. The effects of this specialization are interesting and entirely in accordance with modern progress, and this one fact contributes largely to the success of the American manufacturer of machine tools in producing an article of the best workmanship and most approved design at the lowest price. As in chemistry, medicine, surgery, or any of the arts and sciences, the field in machine construction is to-day so wide that it is impossible for any one mind to grasp all the details of its different departments, or to master the immense number of facts which are being collected, and the theories which are being developed, by specialists. A natural segregation has occurred in all the arts and sciences, and the American idea of specializing in the manufacture of machine tools is but a practical application of this principle, which is being adopted in every calling. European nations must follow the same lines, if they hope to compete. We have specialists in art, medicine, law, in all professions and in many industries, why not in the manufacture of machine tools? There are, and will continue to be, conditions which call for all-round mechanical engineers, but certainly the field for such is decreasing.

It will be well to call attention to some of the good effects which specialization has on general manufacture, and to the resulting advantages which the American maker of machine tools is securing in competition with Europeans. In the first place, special engineers are being produced,—men who are confining themselves to the study of one class of machinery, and are constantly working at the design of a particular line of tools. They study to increase the capacity of these

machines, to broaden the field of their application, and to make them cheaper. These special engineers are becoming a necessity to manufacturers, and they occupy to-day, in America, a recognized position as authorities in their special lines. Their standing and reputation are of commercial value to the companies with which they are connected, and are the equivalent of a good will, which is a valuable asset. The effect of their work is to develop and produce a machine best adapted to the end in view, and to make it at a price with which the manufacturer of many and varied classes cannot possibly compete. This method of working has also produced a class of expert workmen and tool makers who, by confining themselves wholly to one branch, have had the opportunity of designing special tools for the production of their class of machinery, and have become, by experience, so adept at their work as to be able to turn out machines with a high degree of accuracy, and a good finish, at a low price. Each specialist is constantly exerting himself to make his machine produce the best work, and to make improvements by which he can reduce the costs of manufacturing to his customers. He is ever on the alert to make any new application of his machine, to enable him to compete with makers of other lines.

There are many interesting examples of this specializing competition, one of which is that of the planing machine and the milling machine. A short time ago the wonderful results produced by the milling machine were proclaimed by many as the precursor of the downfall of the planing machine. To-day it seems to be fairly settled that these two machines should work in the most friendly way, and that alternate planing and milling on the same piece is, in many cases, the most advantageous way of producing good work. The planing machine is now made in America by several companies that make no other machinery; the same can be said of the milling machine. The result is that both are made better and more cheaply than ever, and the product of each is largely increased. The same contest has taken place between the turret machine and the lathe. We find work being done on the turret machine which was formerly done on the lathe, and, at the same time, better results are attained on both machines; that is to say, the lathe and the turret machine are producing the cheapest and best work by an interchange of operations.

Similar improvements are the result of the study of the grinding machine by specialists. Parts are roughed out on the lathe nearly to size, and then finished truly cylindrical, and to gauge, on the grinding machine. With this method no special skill is necessary for either operation; that is to say, no specially skilled "turner" is

necessary, and exact results are attained on the grinding machine by workmen who have served no long apprenticeship.

One of the most striking results of specialization has been in the recent development of the automatic screw machine. This machine, which was originally used for the production of small parts, mostly machine screws, is now made to turn out many complicated and expensive forms. Bicycle hubs, ball handles, and complicated parts, drilled out, turned all over, and threaded, are now produced on the automatic screw machine from a bar of material, one workman attending from six to ten machines. Only a few years ago this was unthought of, or deemed impossible. The development of this class of work may be attributed wholly to specialization of talent, plant, and management.

Not only are the Americans sending abroad quantities of machines adapted to special purposes,—largely bicycle parts,—but there has also been a very large exportation from the United States of regular machine tools, such as lathes, milling machines, planers, drilling machines, etc. In the regular lines of machinery, like the above, where advantages common to special machinery are not an inducement to buy, the machine being a regularly-catalogued article, the American makers are competing with the European manufacturer. This success is also due almost entirely to specialization. Factories could be named where these results are attained through no particular superiority in design of the machine, but simply through the fact that the whole engineering and commercial staff is devoted to the production of one article. Such machines as lathes and drilling machines are turned out in lots of one hundred, and even larger quantities. Parts, such as head-stocks, tail-stocks, or slide-rests, are "jigged" like sewing-machine parts, holes being bored, drilled, and counterbored without the use of a boring mill. Smaller parts, such as hand wheels, change gears, or cone pulleys, are made in still larger quantities, and are carried in stock. All these smaller parts are made interchangeable and to gauge, and are held in readiness to be put into machines as fast as they are to be assembled. In this way machine tools are "manufactured," and the operations are largely performed by comparatively unskilled labor. How is it possible for those who make one machine to order, or make small lots, as manufacturers of a great variety of machine must do, to compete with these methods?

It should be mentioned that some results not altogether desirable are noticeable in American practice where special efforts have been made to reduce machine-tool production to a manufacturing basis. Some of the American makers have gone so far in their efforts to produce quantity that they have sacrificed quality. Machine tools can

be "manufactured" up to a certain limit; beyond that they must be "made." The great bulk of machine tools can be turned out in quantities at a low cost, but the fine, accurate machinery, which is really the foundation of all good and cheap production, calls for the highest skill of the experienced workman, as well as for the finest judgment in design. The ideal machine shop is one in which the most rational methods of manufacturing are combined with the most accurate finish and thorough inspection.

In America the practice is also thoroughly established of separating the heavy from the light machine-tool manufacture. This is done by European makers, although not so extensively or effectively. No makers of note in America are producing both light and heavy machinery. On the other hand, in European countries it is the rule rather than the exception for machine-tool makers to produce both heavy and light machinery. This is difficult. The engineering problems are so different, there is such a variation in the demands of customers, and the plants and workshops best adapted for the manufacture of heavy or light machinery are so dissimilar, that the two branches cannot be worked together satisfactorily.

Some of the success of the American machine tools in the European market is undoubtedly attributable to the fact that the specialized manufacturer is largely used as a consulting engineer. European manufacturers are making extensive use of the American specialist as a source of information by which their articles can be more accurately and cheaply produced. All this consulting work is free to the customer, the machine-tool maker getting his "fees" through profits on tools supplied. In addition to the technical advantages which can be offered on account of specialization, the salesman also finds it to his benefit to make a particular study of the wants of customers, and in this way to extend the interest of all concerned. This matter will receive special attention in a later article, as it has an important bearing on the questions before us.

The practice of European as compared with that of American mechanical engineers is stated in the interesting address given by Mr. G. F. Deekin before the British Association, at its last year's meeting in Montreal. Mr. Deekin is evidently not acquainted with the latest practice in America, for, in speaking of the successful careers in the engineering profession, he remarks: "It is sometimes useful to observe these careers, and, whenever we do so, we find the very reverse of specialization." This is true, speaking broadly of the engineering profession as practiced by Europeans, but it is not in accordance with modern methods. The times are passed when an engineer, a mechanic, or any industrial or scientific worker could successfully pursue

every branch of his calling. Julius Cæsar was great as a soldier, an architect, a historian, and a statesman, but such a character is impossible in the nineteenth century. No man can, at the present time, pretend to be great in all lines. The accumulated knowledge of centuries is too vast to be at the command of any one mind, and general progress is too rapid to be kept pace with by any individual worker. It is but in accordance with the times and modern requirements that machine-tool engineering, like other things, should specialize itself. Whatever the calling may be, the successful man of to day must make that calling his special study, and he can give but little attention to other lines.

With respect to the European situation, it must be admitted that specialization of manufacture in the machine-tool business is but slightly developed. Not one case of a company in Europe devoting itself wholly to one line of machine tools is known to the writer. Such companies may exist, but they certainly have neither the reputation or the standing that we find among American manufacturers of machinery. The hap-hazard practice of European machine-tool makers has a noticeably bad effect in many ways. One of the most serious is that it operates to produce indifferent workmen and designers,—men without any special training, experience, or interest in any particular line. Men who are making a steam engine or a boiler one day, working on a lathe next week, and operating a planing machine the week after, cannot be expected to have any particular interest in a special line, or any skill in making or developing that line. The results are, of course, slow progress in design, little application of improved methods, and indifferently-made machinery. The evil effects are seen throughout European workshops, in their equipment and organization. Even the simplest articles cannot be properly manufactured on crudely-developed machinery. There are various conditions affecting European makers which do not, of course, influence American manufacturers. The conditions of trade are not alike, particularly as carried out by exporting houses in London, Antwerp, or Hamburg. Undoubtedly the peculiar state of the European machine-tool makers has been partly brought about by their large export trade, and the fact that they undertake to produce every article called for by foreign enquiries or indents, where complete plants are required. But no conditions can justify the present attitude of the European maker of machine tools. He must apply himself to one line, and perfect and develop that line, avoiding both general manufacturing and general trading.

EQUIPMENT, MANAGEMENT, AND ECONOMIC INFLUENCE OF THE SHIP CANAL.

By W. Henry Hunter.

TAKING, as examples of the two types of canal dealt with in these articles,* the Suez canal, exemplifying the through-road waterway, and the Manchester ship canal, exemplifying the *cul-de-sac*, the results of the construction and working of the two waterways may already be seen in measure.

Few care to remember now the scorn and derision with which M. Ferdinand Lesseps was met when he first proposed to revive the ancient project of a canal between the Mediterranean and the Red sea, and thus provide a new route from Europe to the east.

It was shewn, it was demonstrated, that from an engineering point of view the thing was impossible, simply absurd, while from a commercial point of view it was proved, up to the hilt, that, even if the canal could be made, it would, so far as traffic went, be a failure as melancholy to the philanthropist as it would be disastrous to the investor. The great authorities who spoke thus with so much assurance and in so fine a prophetic vein are all dead, and it is well for their comfort that they are. The merest school-boy to-day knows the Suez canal as one of the great triumphs of the century, and, whatever clouds may have gathered around M. Lesseps's closing days, he made the Suez canal, and will, so long as time may last, have a place among the benefactors of mankind.

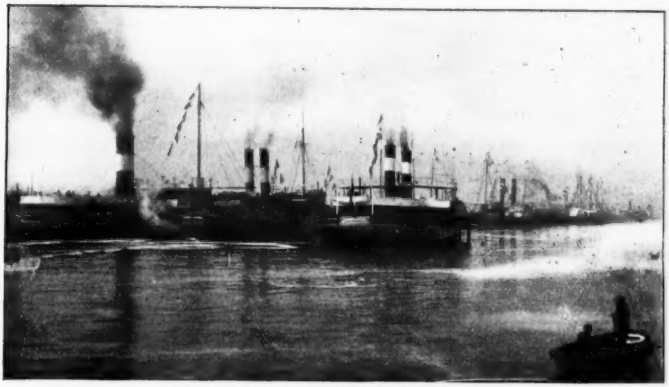
In 1869 traffic *via* the Cape of Good Hope was about 3,500,000 tons. In 1897 the traffic through the Suez canal was 7,898,981 tons, while that round the Cape of Good Hope was at least 3,750,000 tons—all figures being registered tonnage, much less than actual weight.

In other words, one direct result of the construction of the Suez canal has been that in twenty-eight years the commerce of the world has been increased by some 8,000,000 tons annually.

The value of this increase to humanity cannot even be guessed at; the ramifications are too great and the effects too far-reaching.

It is hardly necessary to add that the return to the investor who risked his money in what seemed to so many to be a hare-brained project has been, to say the least of it, of a fairly satisfactory character.

* Mr. Hunter's former article, in December, depicted the importance of the ship canal in uniting the seas which, in turn, "unite continents." He traced its enormous influence upon the effective utilisation of the world's wealth, and sketched the functions and necessary equipment of the two principal types—through and terminal.



TRAFFORD WHARF, MANCHESTER SHIP CANAL.

The Manchester ship canal differs from the Suez canal in that (*a*) it is not yet five years since it was opened to the trade of the world, and (*b*) the results of its working are of a more local character, although by them the well-being of millions of persons has been directly affected, while indirectly these results are well nigh, if not altogether, of national import. The returns of traffic carried on the canal since its opening are as follows:

1894.	925,659	tons
1895.....	1,358,875	"
1896.....	1,826,237	"
1897.....	2,065,815	"
First half of 1898.....	1,173,880	"

Not very large figures, but larger than those of the trade through the Suez in the same respective times.

MODEWHEEL LOCK.

And, as there has been no diminution of the trade of Liverpool in the years specified,—there has been, on the contrary, a distinct increase of that trade,—the Manchester ship canal figures represent a positive addition to the commerce and an increment of the wealth of the country. Other effects are shewn by the table.

COMPARISON OF RAILWAY RATES

Before the passing of the Manchester Ship Act, 1885, with those of the present time.

Stations Between	Description of Traffic.	1884.	1898.
		s. d.	s. d.
Liverpool and Manchester	Cotton	8 S to S	7 2 S to S
	Grain	7 4 4 tons collected	6 11 4 tons collected
	Timber	7 6 " "	6 8 " "
	Pig Iron	5 9 British 6 4 Foreign	4 2 S
	Sugar	6 8 2 tons S S	6 8 5 tons S S
	Machinery	9 2 S to S	9 2 S to S
	Bacon and Hams (packed)	10 "	9 2 "
	Dyewoods (class 1)	8 "	7 11 "
	Iron and Steel (class c)	6 8 "	5 10 2 tons S to S
Liverpool and Stockport	Cotton	8 "	7 2 S to S
	Grain	7 4 4 tons collected	6 11 4 tons collected
	Timber	7 6 " "	6 8 " "
	Pig Iron	6 3 S S	4 4 S S
	Sugar	6 8 2 tons S S	6 8 5 tons S to S
	Machinery	9 2 S to S	9 2 S to S
	Bacon and Hams (packed)	10 "	9 2 "
	Dyewoods (class 1)	7 6 "	7 11 "
	Iron and Steel (class c)	7 6 "	6 8 4 tons S to S
Liverpool and Staleybridge and Ashton	Cotton	11 3 "	10 5 collected
	Grain	8 2 4 tons collected	7 9 4 tons collected
	Timber	8 4 " "	7 6 " "
	Pig Iron	5 2 S S	4 5 S S
	Sugar	10 2 tons S to S	7 6 5 tons S to S
	Machinery (in cases)	11 8 S to S	10 10 S to S
	Bacon and Hams (packed)	11 8 "	10 10 "
	Iron and Steel (class c)	8 4 "	6 3 2 tons S to S
Liverpool and Bolton	Cotton	8 4 collected	8 collected
	Grain	8 C and D	7 11 C and D
	Timber	6 10 S to S	6 6 S to S
	Pig Iron	5 5 S S	3 8 S S
	Sugar	9 2	9 2 collected
	Machinery (in cases)	10 carted	7 6 S to S
	Bacon and Hams	10	10 collected
	Iron and Steel (class c)	7 S to S	5 10 S to S
Liverpool and Bury	Cotton	9 2 "	8 4 "
	Grain	8 3 collected	7 6 4 tons collected
	Timber	9 2 "	7 3 " "
	Pig Iron	5 6 S S	4 5 S S
	Sugar	10 10 S to S	8 4 10 tons S to S
	Machinery	11 8 "	9 2 S to S
	Iron and Steel (class c)	7 6 2 tons S to S	6 3 4 tons S to S 6 8 2 tons

The capital of the Manchester Ship Canal Company stands at present at £15,412,000, divided, in order of priority for interest, as follows:

Debenture stock	£2,412,000
Manchester Corporation loan	5,000,000
Preference shares	4,000,000
Ordinary shares	4,000.000
Total	£15.412,000*

* This sum includes the price paid for the Bridgewater canal and for a vast area of surplus lands, as well as the amount of £1.170,733, paid as interest out of capital.

During the first half of the present year the earnings of the ship canal and the Bridgewater canal were sufficient to provide for all working expenses and maintenance, and to pay interest on the debentures.

There can be no doubt but that, on the closing of the accounts for the present half-year,* the revenue will, in addition to meeting the foregoing claims, leave some margin, which can go toward paying interest on the corporation loan.

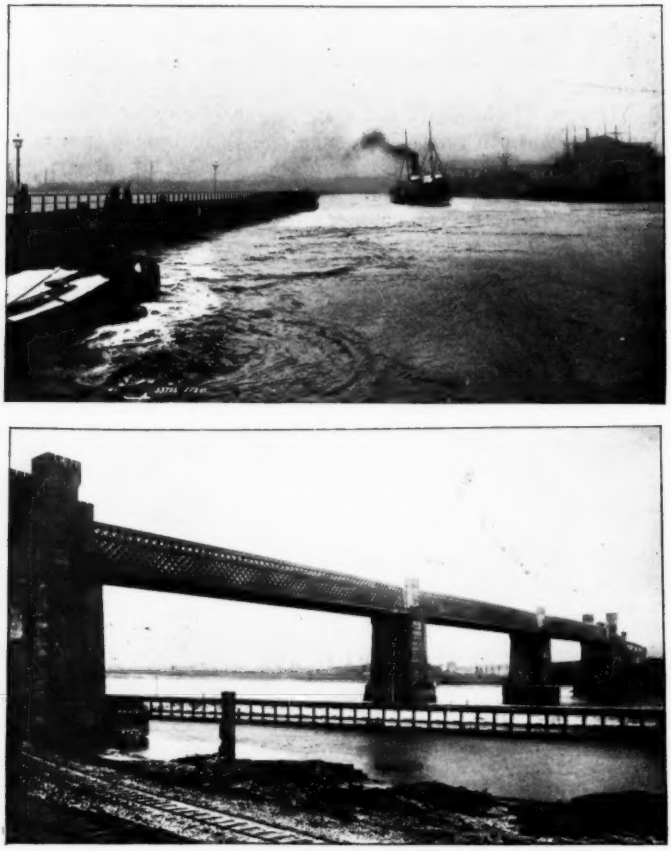
This of itself shews that steady progress is being made; but, taken by itself, it furnishes a very inadequate representation of the results of the working of the canal.

GENERAL VIEW OF MANCHESTER DOCKS.

Recently Mr. Reuben Spencer, the head of the great Lancashire firm of John Rylands & Son, and than whom there is no greater authority on the subject, stated publicly that the citizens of Manchester were receiving, in benefit to trade and in increased prosperity, no less than twenty per cent. per annum on the money which the corporation had invested in the canal, or, in other words, that the waterway is *at the present time* worth £1,000,000 annually to Manchester.

On September 7, 1898, Mr. Spencer's words were corroborated in a strikingly practical way, in the city council, by Sir John Harwood, the chairman of the waterworks committee, who announced that a reduction of the rates for water, both in the city and in the

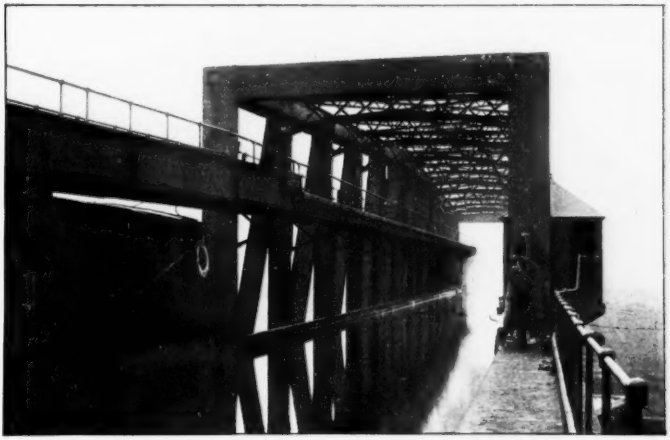
* The second half of 1898.



RUNCORN CANAL AND RAILWAY BRIDGE, MANCHESTER SHIP CANAL.

district beyond its boundaries, would be made at once, which would, at the present time, be equal in value to £35,000 per annum. The significance of this fact can be appreciated only by recalling to remembrance the work which that waterworks committee has accomplished.

In 1894 the Thirlmere waterworks were opened, as an addition to the previous supply from the Longdendale reservoirs. The total cost of the Thirlmere works was £2,696,899 17*s.* 1*d.* A sinking fund has been established, through which the whole of the indebtedness, *qua*

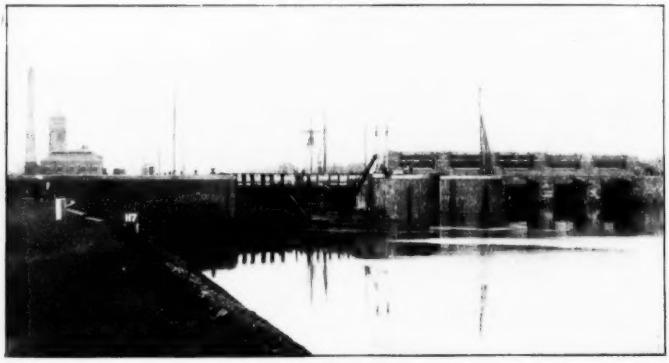


BARTON AQUEDUCT. SWINGING SPAN OVER THE MANCHESTER SHIP CANAL.

the Thirlmere works, will be discharged by January 1, 1960. Notwithstanding this great addition to the annual charges, the waterworks committee were able to recommend a reduction of the charges for water, which would reduce their income by the large sum named.

What is the explanation of the seeming paradox? It is a short and simple one. The demand for water, both for trade purposes and for domestic consumption, has increased so enormously, the revenue

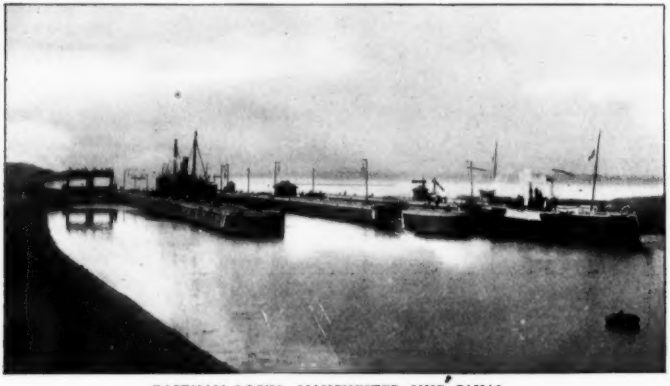
OLD BARTON AQUEDUCT, THE FIRST CANAL AQUEDUCT BRIDGE AND THE PREDECESSOR OF THE FIRST AQUEDUCT DRAWBRIDGE, SHOWN ABOVE.



IRLAM LOCK.

advancing with corresponding rapidity, that the waterworks committee can comfortably meet all their liabilities, and yet lower their rates thus substantially.

No competent person would, for a moment, hesitate, if asked for the reason for this unparalleled progress. It is one of the results of the construction and working of the Manchester ship canal. In the district served by the Manchester waterworks decaying industries have been revived, new industries have been introduced, the movements of trade have been quickened, the population has been increased, and there is no cause to which it all can be attributed except the canal,—no new feature which can be suggested, except the opening of the waterway. Nowhere has the change been more marked than in Manchester

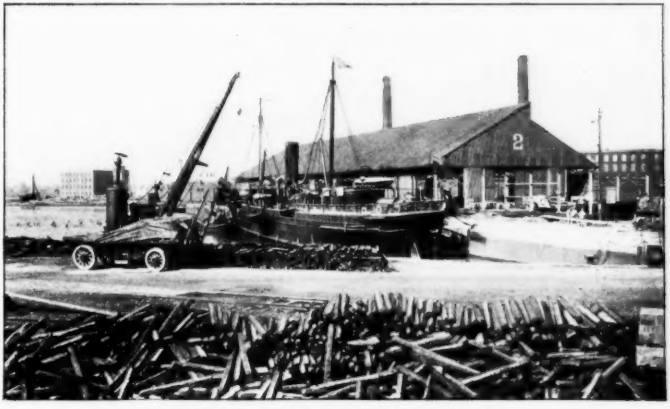


EASTHAM LOCKS, MANCHESTER SHIP CANAL.

itself—in Greater Manchester, which includes the boroughs of Salford and Eccles, and the other districts which encircle and enclose Manchester, and in the city proper.

In 1882, when the canal project, under the guidance of the late Mr. Daniel Adamson, first took shape and began to gather force, Manchester was a city upon which the marks of decrepitude were beginning to make themselves but too apparent. Disused factories, empty warehouses, uninhabited dwellings, were bearing widespread and ominous testimony to the decadence of the great manufacturing centre, and to the inability of the community to maintain the pre-eminent position which their predecessors had achieved.

In 1898 how great the contrast! Manchester has renewed her youth. On every side and towards every point in the compass she is



POMONA DOCKS, MANCHESTER SHIP CANAL.

lengthening her cords and strengthening her stakes; building operations, whether in the way of raising palatial business premises in her centre or of erecting factories and residential property in her constantly-extending outskirts, are progressing at a rate which has had no parallel in the long history of the town*; the streets are so thronged with traffic that the problem of dealing with them in such manner as to avoid positive congestion is forcing itself upon the inhabitants, the regulating hand of the law in the clothing of a policeman's glove

* Towards the close of the municipal year 1897-8 Mr. J. R. Wilson, a member of the Manchester city council and of the improvement committee of that council (the committee to whom all plans for new buildings within the area of the city are submitted) informed a public meeting of ratepayers that, since the opening of the canal, no fewer than *twenty thousand new houses* had been built in or near Manchester, and that plans had been passed for *nine thousand more*. Mr. Wilson further stated that in 1891, before the opening of the canal, there were five thousand unoccupied dwelling houses, which at the present time are all tenanted.

SLUICES ON THE WEAVER.

being required already at almost every crossing of important streets; returns of the railway companies, running into Manchester shew an annual increase so marked that company after company has initiated and carried out, or is in course of carrying out, additions and improvements of a most extensive character, having for their object the increase of their conveying and storing capacity; in a word, threatened decay has been turned into vigorous growth, and adversity into prosperity.

40,000-TON GRAIN ELEVATOR, MANCHESTER DOCKS.

The Manchester men did not "wait till the clouds rolled by"; they made the ship canal, and they are beginning to see the sun shine again, and to reap the fruits of their enterprise, even though as yet but little direct return has been received in the way of interest on the bulk of the capital invested.

TWIN TREBLE-STORY SHEDS, MANCHESTER DOCKS.

It does not demand the assumption of the mantle of the prophet for one to say that the time when interest will be paid on all the capital will come, for the work is only beginning. Many lines of trade are still susceptible of great development; many possible and promising departments of

commerce have not yet been touched, and of others only the fringe has been reached; but the progress which is being made is on the lines of least resistance to which reference was made at the beginning of these articles. In other words, it is *with*, and not *against*, nature and natural development, and it furnishes a striking example of the results which may be expected to follow the construction and working of a prudently-conceived maritime canal.

Objection has been made to the increase of competition, already so keen, which must be occasioned by the construction of waterways of the classes to which reference has been made, thus rendering the struggle for existence more acute, and making the doctrine of the survival of the fittest, with the complementary doctrine of the destruction of the least fit, more of an experience in actual life.

The objection cannot be maintained, in view of the better understanding which has been arrived at, by the philosophical scientists of our own time, of the functions of competition in the progress of humanity.

MANCHESTER SHIP CANAL.

COMPARATIVE COST (at per ton of 2240 lbs.) OF CONVEYING

MACHINERY, IN PARTS, IN CASES,

To various towns from ex Ship LIVERPOOL and ex Ship MANCHESTER respectively.

MANCHESTER PORT CHARGES.	s.	d.		LIVERPOOL PORT CHARGES.	s.	d.
Ship Canal Toll....	4	0	Included in Through Rate, Column 1.	Dock and Town Dues.....	2	0
				Master Porterage.....about	1	9
				Attendance at Ship and Forwarding	1	0
				Cartage to Railway Station	1	3
Quay Porterage....	2	0				
	6	0			6	0†

† Included in cost via Liverpool, shown below.

TO	1 Ex Ship MANCHESTER			2 Ex Ship LIVERPOOL			3 Saving in favour of MANCHESTER	
	s.	d.		s.	d.		s.	d.
Accrington	13	0	O.R.	18	6	O.R.	5	6
Birmingham	24	0		27	10		3	10
Bradford	17	6		23	6		6	0
Chesterfield	19	6		27	10		8	4
Derby	22	0		28	9		6	9
Halifax	16	6		22	7		6	1
Huddersfield	15	6		21	10		6	4
Leeds	17	6		22	9		5	3
Leicester	26	6		32	3		5	9
Manchester	6	0		15	2		9	2
Northampton	31	0		33	10		2	10
Nottingham	23	9		30	6		6	9
Sheffield	18	0		26	11		8	11
Stoke-on-Trent	14	7		21	9		7	2
York	24	0		32	8		8	8

MANCHESTER SHIP CANAL.

COMPARATIVE COST (at per ton of 2240 lbs.) OF CONVEYING

IRON AND STEEL, 2-TON LOTS,

unless otherwise stated,

To various towns from ex Ship LIVERPOOL and ex Ship MANCHESTER respectively.

MANCHESTER PORT CHARGES.	s.	d.		LIVERPOOL PORT CHARGES.	s.	d.
Ship Canal Toll....	3	0	Included in Through Rate, Column 1.	Dock and Town Dues..... about	1	0
				Master Porterage ..... "	1	1
				Attendance and Forwarding.....	0	3
Quay Porterage.....	1	0		Cartage to Railway Station.....	1	3
	4	0			3	7†

† Included in cost via Liverpool, shown below.

TO	1 Ex Ship MANCHESTER			2 Ex Ship LIVERPOOL			3 Saving in favour of MANCHESTER	
	s.	d.		s.	d.		s.	d.
Accrington	8	0		11	6		3	6
Birmingham	13	0	delivered	13	7	delivered	0	7
"	11	4	4 tons	11	11	4 tons	0	7
"	10	8	10 tons	10	8	10 tons		
Bradford	10	0		12	9		2	9
"	9	6	4 tons	12	4	4 tons	2	10
"	8	9	10 tons	12	4		3	7
Derby	12	0		16	1		4	1
"	10	6	4 tons	12	9	4 tons	2	3
Halifax	9	6		11	11		2	5
"	8	9	4 tons	11	11		3	2
Leeds.....	10	0		12	9		2	9
"	9	6	4 tons	12	4	4 tons	2	10
"	8	9	10 tons	12	4		3	7
Leicester	13	10	4 tons	17	7	2 tons	3	9
Manchester	4	0		9	5		5	5
Northampton.....	16	0		19	9		3	9
Nottingham.....	12	6		16	1		3	7
"	12	0	4 tons	15	3	4 tons	3	3

In that progress competition is as the breath of life. Without it not only can nothing more be achieved, but that which has been achieved cannot be maintained. Without it degeneracy, which will affect not only the material prosperity and the comforts of the people, but also the moral fibre of the race, will take the place of development. Without competition, mankind will go backward, and that in an ethical as well as a material sense; for it is not only *a* means by which human exertions are quickened and human energies braced, but it is *the* means through which those who are most competent to guide, to direct, and to help their fellows find their true place in the forefront of the battle; and there are to-day few, amongst those whose judgment is of value, who will deny that this tends to raise the tone and the standard of the whole race, and is therefore for the benefit of all.

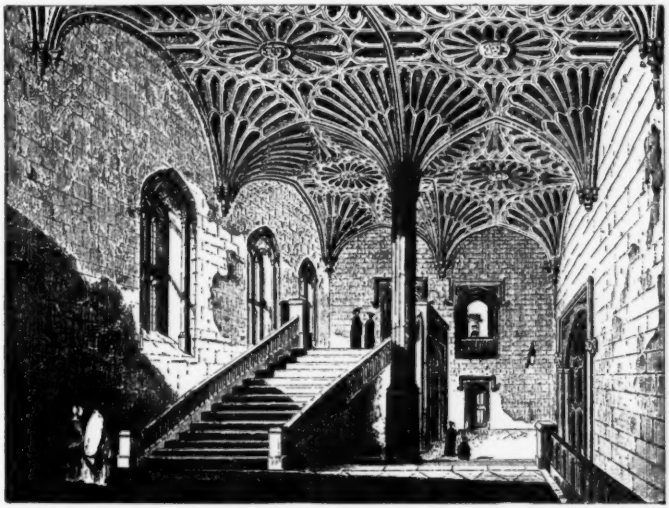
THE BUILDINGS OF OXFORD FROM AN ENGINEER'S POINT OF VIEW.

By J. W. Parry.

FOLLOWING our review of some of England's most famous structures from the new viewpoint of an engineering examination, we considered briefly, in the preceding number of THE ENGINEERING MAGAZINE, the principal features to be observed in passing down the High and through King street, until we arrived at S. Aldate's.

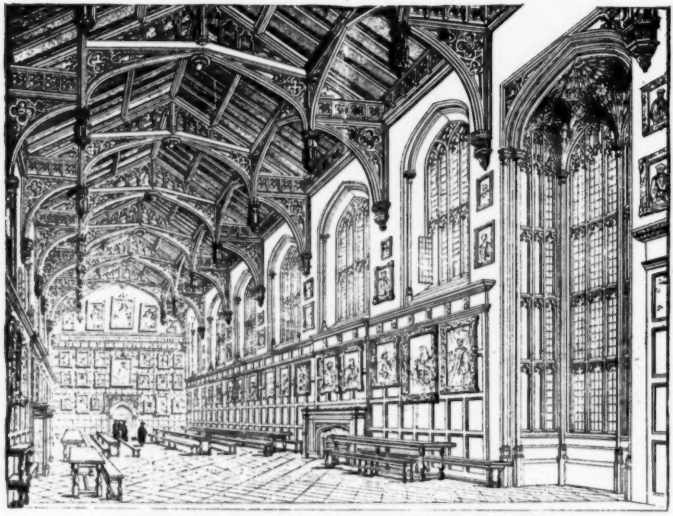
We shall enter Christ Church from S. Aldate's under the Old Tom gateway, though, to have followed the sequence of this narrative, we should enter through the Canterbury gate. Much might be written about this magnificent college, but only a few important features can be brought forward here.

The great quad measures 264 by 261 feet, and is exceeded only by that of Trinity College, Cambridge. The southeast and west portions were finished by Wolsey, who intended to place a handsome church on the north, but fell into disgrace before the design could be com-



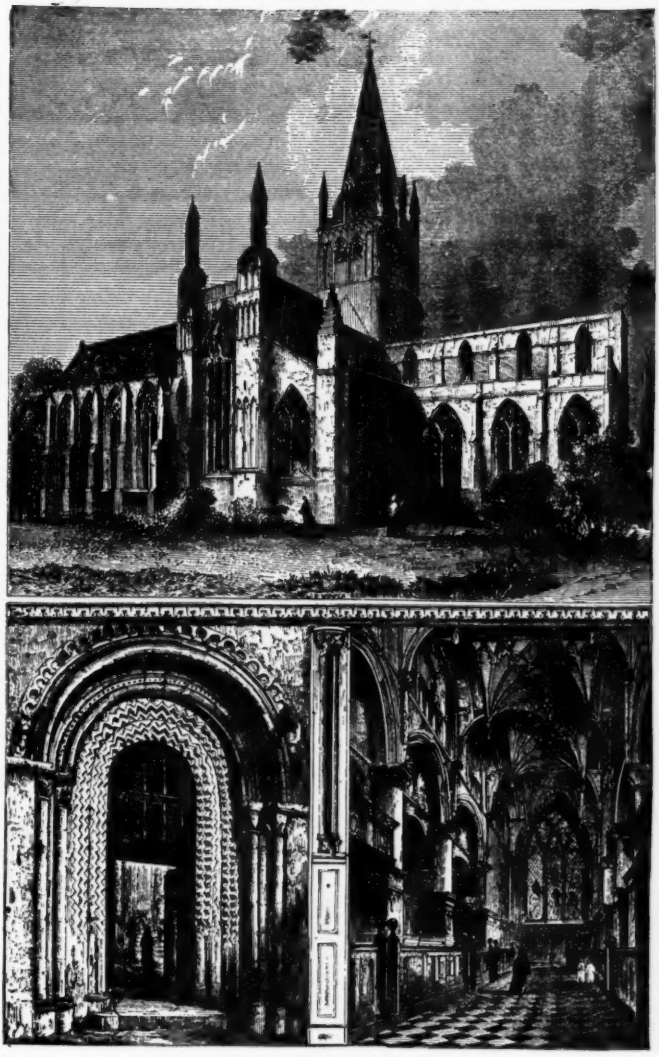
ENTRANCE TO DINING HALL, CHRIST CHURCH COLLEGE.

pleted. It is stated that in 1528–1529 Wolsey spent £7,835 on his college, which he expected to be the most magnificent in the world. There was to have been a handsome cloister around this quad, as the projecting piers and commencement of ribs testify. The kitchen still retains its original size, shape, and interior arrangements of roof and fireplaces, being one of the finest specimens in England. The entrance to the hall is about 40 feet square, and the vaulted stone roof, of exquisite fanwork supported by a single slender pillar, justly claims admiration from every engineer or architect. The magnificent hall, 115 feet by 40 feet, and 50 feet high, shows Wolsey's vast intentions, the carved roof being profusely decorated with armorial bearings.



INTERIOR OF THE HALL, CHRIST CHURCH COLLEGE.

In the cathedral we see the three-fold division of pier arches, triforium, and celestory; at one time it was intended to add another stage, but, as cracks and fissures began to appear, the square tower was made into a spire having a pyramidal coping of stone. While the majority of the columns are cylindrical, four are octagonal, and their treatment is peculiar. The main pillars of the building are, as it were, halved when they reach ten feet in height; one-half is continued upwards to its half capital, from which spring the ribs of the higher vaulting, and the other half is stopped by a half capital, from which start the ribs of the aisle-vaulting. Similar treatment of shafts is to be seen at Hyde abbey and Winchester. The choir is specially



OXFORD CATHEDRAL.

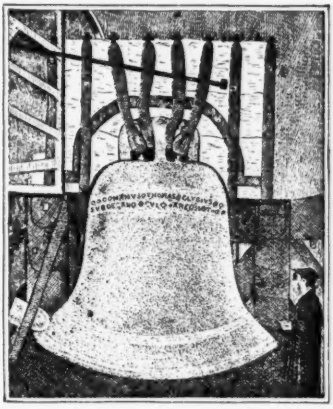
worthy of study, on account of the double arches, a lower arch springing from the corbels attached to the piers and rich pendants. There is similar "Stella" vaulting at Tewkesbury; St. George's, Windsor; Kings College, Cambridge; and Henry VII's Chapel, Westminster.

In the Lady Chapel there are the remains of three narrow entrances, which, Mr. Park Harrison thinks, were three apses, while Mr. James Parker says that they were barrow-holes; they certainly look more like the latter. In the Latin Chapel there are arches of the twelfth, thirteenth, and fourteenth centuries contiguous to one another; we see that the mouldings differ. In 1856 a small crypt was discovered —of Norman times, and unique of its kind; it is conjectured that it was used as a secret chamber to contain the S. Frideswide or University chest. On going into the roof of the choir, the writer was surprised to find an air space, and then a second roof on trusses covered with lead. Examination of several old roofs indicates that this precaution was generally adopted in England wherever groined vaulting was used. The writer has constructed cylindrical vaulting, and domes as well, on the Indian State railways, but he certainly did not place a second roof above either of these coverings, although the rainfall in India is far heavier than that of England. The Chapter House is said to be an admirable instance of early English architecture, the door being Norman. The passage between the cathedral and the Chapter House is termed a "slype."

It is necessary to notice the handsome Broad walk, with its avenue of trees leading to the river, which was raised above flood-level with the stone chippings left from the buildings, and was called White walk, then Wide walk, and finally Broad walk.

Over the entrance to the hall is the campanili containing the belfry. The "merrie Christ bells" were removed from the old tower of the cathedral to the campanili, though the walls of the former had been strengthened by bands of wrought iron 8 inches deep and 1 inch thick all round the tower, as well as tie rods through the tower. It has been found that the walls of the campanili are made of excellent masonry, being probably intended to hold the bells in Wolsey's original design. There are twelve bells, ranging from 400 to 3,000 pounds, and no cracks have been visible, though the bells have been ringing for thirty-five years (1863). Here it may be added that the Tom Tower contains a bell 7.8 tons in weight,—one of the largest in England,—which tolls 101 times at 9 P. M. The timber framing is one of Wren's best designs. No one would venture, however, to ring or turn such a mass; the heavy clapper is merely pulled against the side of the bell, as shown in the quaint illustration. The framing consists of four raking pieces 15 inches by 12

inches, firmly bedded into two large timber beams which rest on the walls, and connected at the top by two horizontal beams; in addition, there is cross bracing at different heights. Across the two upper horizontal beams there is a mass of timber, 7 ft. by 3 ft. 9 inches deep by 1 ft. wide, from which the bell is slung. What excites our admiration is the lifting of nearly 8 tons to a height of 275 feet with pulley blocks and winches alone—for it must be remembered that hydraulic machinery, steam cranes, screw jacks, steel joists, and deep iron girders were unknown in Wren's time. The illustration only shows the large timber mass from which the bell is slung; this mass has several through bolts and seven iron straps.



WREN'S METHOD OF SUPPORTING 7½ TONS.

Pembroke College.—This is chiefly famous for being Dr. Samuel Johnson's college, his rooms being shown above the entrance gateway. The hall has a hammer beam roof with a louvre, which often leaks after a storm. The chapel is ornamented with Ionic pilasters between the windows. There is certainly an unusual amount of dim religious light in the chapel, due partly to the dark-colored glass, and partly to the thick framework of iron behind the glass. In the Senior Commons room is a drawing showing that the previous chapel was attached to S. Aldate's Church, with the library above; since then the old hall has been converted into the present library.

S. Martin's Church Carfax.—The meaning of Carfax is quatre voies, or quadvivium, or the meeting of four ways. The foundation of the church is "beyond all record." The advowson was given by Canute to the Benedictine Monks in 1032. A small portion of the original structure may possibly exist, but the tower was pulled down in Edward VI's time, as the people annoyed the scholars with arrows and stones, giving rise to the gown and town riots. The above is stated by Messrs. Ingram and Parker. On the other hand, Mr. Hurst insists that the document appealed to has reference, not to a tower, but to an aisle. The foundations of the tower are more than twelve feet below Queen street. On examining the stratification it becomes apparent that the street has been gradually raised this amount; during high floods even this part of the city was liable to

be submerged. In 1894 the church was pulled down to widen Queen and Cornmarket streets.

Previous to 1787 there was a conduit or fountain for supplying the colleges and halls with water, but, as it blocked the way, it was presented by the authorities to Sir Vernon Harcourt, who has reconstructed it at Nuneham.

Lincoln College.—On entering the northern quad one cannot help noticing the belfry over the present library, which formerly was the chapel. The roof of the hall was reopened and restored in 1889; previously it had been covered with lath and plaster. Beyond is the old kitchen with thick walls, said to be of the thirteenth century; still further on is a small door leading into Brasenose.

Passing into the chapel one can at once smell the cedar in the wainscotting, screen, and Wycliffe's pulpit. The prophets and apostles on the stalls are finely carved, and the tracery of the window is a good example of the time. The east window has six upper and six lower compartments, showing the types and anti-types of Christianity. The chapel is 62 feet by 26 feet, by 26 feet high; the ceiling is panelled, indicating a trussed rafter roof.

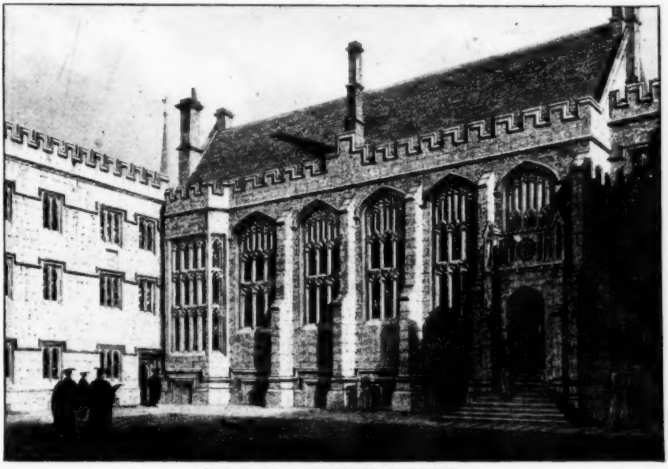
Exeter College.—Few of the colleges have undergone so many building operations and architectural changes as has this, the western gateway alone having been built four times—in 1404, 1600, 1700, and 1834. The original chapel cost £1,400; the present one, built in 1858 by Sir Gilbert Scott, cost £17,000. It is one of the finest in Oxford, being modelled after the Sainte Chapelle in Paris. It is 100 feet high, and has an apse with a groined vault and well-carved ornaments. The exterior buttresses are unnecessarily thick, and scarcely in keeping with the rest of the design.

The hall has a high-pitched roof of handsome framework, with a curious kind of reticulated ceiling, lattice girders with trellis work on the top being an unusual method of construction. In 1832 the college buildings were extended 220 feet into Broad street. In the gardens there are two famous trees, one being Dr. Kennicott's fig tree on the wall and the other Bishop Heber's tree at the end of the walk.

Jesus College.—This building is situated on the opposite side of the Turl, and is chiefly intended for Welsh students. From a drawing in the hall it is apparent that there is a hammer beam roof, which, however, is closed in to make four rooms for the principal's servants. The screen is carved in detail, showing the Welsh dragon and other symbols, the bay window forming a bold projection into the inner quad. The chapel has a panelled roof, carefully restored; when the chancel arch was enlarged, the handsome variegated marble reredos and floor were put in.

S. MARTIN'S CHURCH, DEMOLISHED TO WIDEN QUEEN ST.

S. John's College.—A careful observer may still discover, on the north and south sides of the tower, the ledges which mark the apex and inclination of the former roof, which was not so flat and had no dormer windows. The old sculptured cornice, too, remains on the northern gable. The hall was the refectory of the monks. There is a louvre, which possibly had a bell in it. The kitchen and out offices have some fine old chimneys. The Dons Commons room has wain-



THE HALL OF EXETER COLLEGE.

INTERIOR OF THE HALL, EXETER COLLEGE.

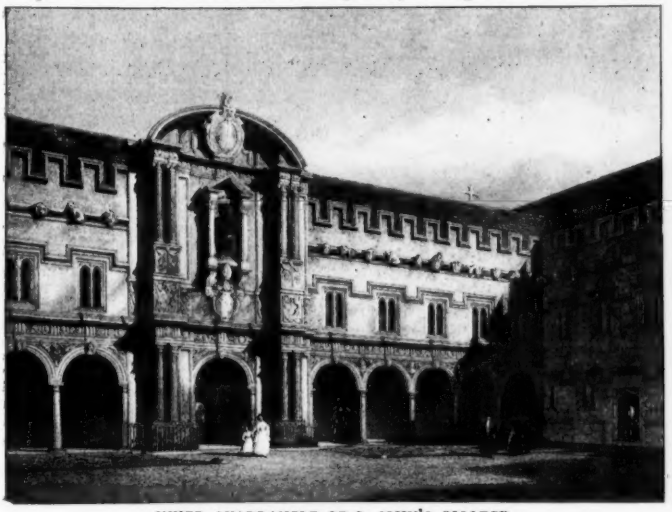
scot covering the whole of the walls, and the ceiling is decorated with shell work in stucco (1676).

The inner quad is occupied by the library, to which King Charles contributed 200 tons of timber from the woods of Shotover and Stow, the designer being Inigo Jones. The colonnade of sixteen pillars consists of Bletchingdon marble in a florid style. The beautiful garden of five acres, having Dutch elms (stunted pollards), boxwood, and other trees, is worthy of inspection. The imitation terrace and

S. MICHAEL'S CHURCH, WITH NORMAN TOWER CRACKED BY RINGING OF BELLS.

wilderness mentioned by Ingram seem not to exist at the present time.

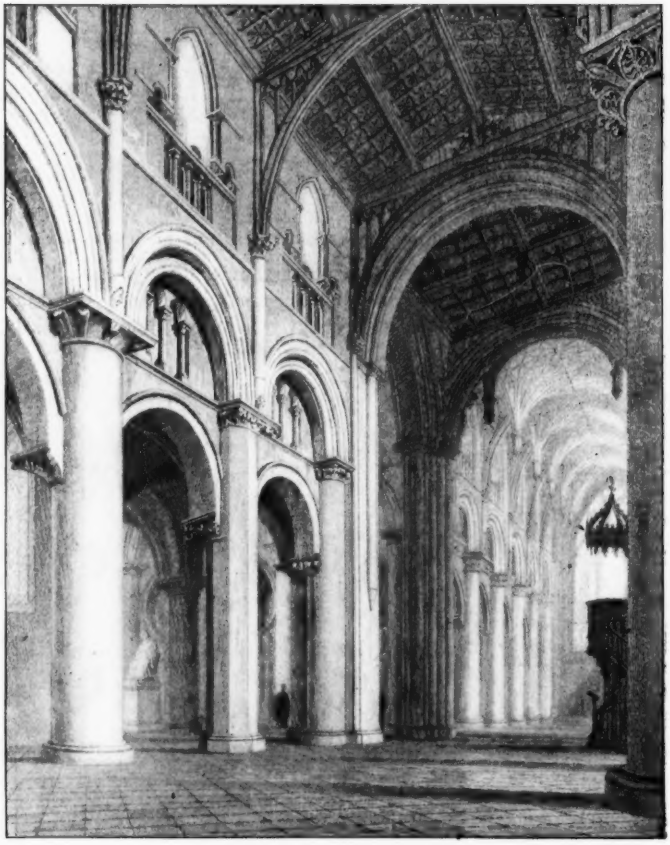
S. Mary Magdalen.—Formerly the north aisle was used as a chapel for Balliol students, subsequently being rebuilt and called



INNER QUADRANGLE OF S. JOHN'S COLLEGE.

Martyrs' aisle. The peculiarity of this church is that its aisles run at right angles to its length; there are four of them, terminating in one line at the east end.

S. Michael's Church.—The most important feature of this church is the tower, which is generally called Saxon, but is really Norman (circa 1080); it is, however, scarcely worthy of the grand Norman builders. The tower formed a protection to the northern end of the city, an arch being turned between this abutment and the present Leopold arms; above the arch was the Bocardo prison. The



INTERIOR OF OXFORD CATHEDRAL.

old city walls were run just to this point, for slight remains of a bastion can still be seen in the cellars of the Leopold arms and the house north of it.

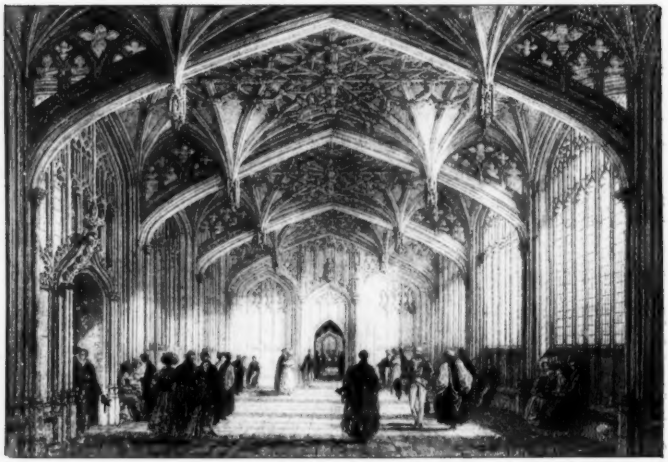
This is one of the churches in which the ringing of the bells cracked the tower, for the bells were hung to ring in the same direction. After patching up the tower, the bells were taken down and deposited in the churchyard; lately, however, they have been returned, and are being re-hung for chiming purposes only.

Balliol College.—The chapel is the fourth since the foundation; it was built in 1856, in different kinds of masonry, abutting Trinity College grounds, the eastern window being of Derbyshire alabaster.

FRONT OF BALLIOL COLLEGE.

The old hall is now a lecture-room, while the new hall is the largest in Oxford, excepting Christ Church hall. The extension on the premises into S. Giles was made in 1869 by Mr. Waterhouse.

Trinity College.—There are two handsome pairs of iron gates, one in Broad street and the other opposite Wadham College. The chapel is said to be one of the best specimens of Corinthian architecture in England; the gateway and tower are of the Ionic order. The carving of the screen and altar piece is chiefly admired, reminding one of the carvings in Burmese pagodas. It is a pity that the north and south wainscot is not also carved or decorated, in harmony with the screen. The ceiling has a large painting by Peter Berchet, unusual in Oxford chapels. The hall is devoid of decorations. The roof was reconstructed at the beginning of this century, and another



THE DIVINITY SCHOOL.

set of rooms added for undergraduates. As a rule, there are no rooms above the halls. Over the end of the hall is a curious old belfry.

Trinity, however, is chiefly noted for its pretty garden of four acres, with its large yews, and for the avenue of lime trees.

The Old Schools.—It is interesting to note that these were erected to accommodate ten schools,—five below and five above. In 1624 the latter were utilised for the Bodleian library, while in 1881 the former also were taken over for the same purpose, new schools being erected in High street. The entrance gateway is a noble one, twelve feet span ; on the inside will be noticed the five classic orders, —namely, Tuscan, Doric, Ionic, Corinthian, and Composite, the plinthus of the columns being enriched with Arabesque ornaments in Elizabethan taste. Passing through the quad, we enter a lofty vaulted passage termed the Proscholium, which was used during the rebellion as a pig market ; through it we reach the old Divinity School.

This is one of the gems of Oxford. The exquisite fan vaulting with figures in the niches has seldom been equalled anywhere. It is known that at one time the windows were filled with richly-stained glass and the roof colored ; the beauty must thus have been enhanced to the ordinary beholder, but not to the constructive eye of an engineer or architect. The pendants are beautifully carved, the bosses being ornamented with emblems, shields, words, or initials of benefac-

tors, or with sacred monograms, some of these being cut in remarkably high relief. Anthony Wood has made a collection of ninety-two of these. By passing through a door at the opposite end of the school we come to the Convocation House, where the statutes for the University are framed and the vice-chancellor holds his court.

Wadham College.—As the site is absolutely barren in Agas's map of 1588, there is no probability that the original stonework of the chapel for the Augustine friars was copied when the college was founded in 1610, as stated by Messrs. Ingram, Parker, and other authorities. The probable truth, first pointed out by Prof. Freeman, is this,—that the masons employed, being Somerset men, continued to build in a kind of Gothic which was prevalent in that county and was one hundred years behind the Gothic in use in any other part of England. The lofty arches and pillars of the ante-chapel are worthy of admiration; the east window is 22 feet span, divided into five compartments. The contract document for this window, £100, in 1621, and detailed accounts of all expenditure since the foundation, have been preserved. In the ante-chapel is the mechanism of the old clock, said to have been designed by Sir Christopher Wren and used till 1870.

The hall is 82 feet by 35 feet, by 37 feet high. The hammer beam roof with its louvre, and the oak screen, should be noticed.

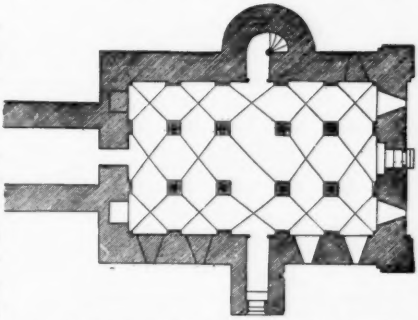
NEW COLLEGE CHAPEL AND TOWER.
The foreground is now occupied by the new buildings.

Hertford College.—The modicum of accommodation in the pigmy chapel here shows how easily the churchmanship of the last century could be satisfied. In modern times it has been rumoured—though tell it not to the principal—that some of the stalwart members of the University football team get cramps in their legs during devotions, and, becoming irritable, wish to "hack it through."

NEW COLLEGE CHAPEL.

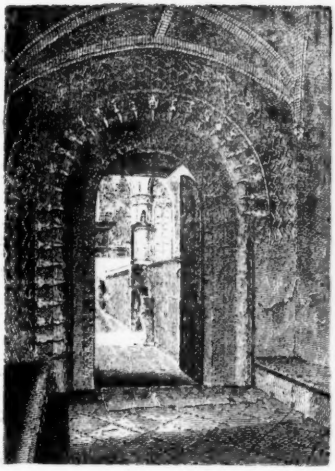
New College.—The legal title given by the founder is "S. Mary's College of Winchester at Oxford." Ingram tells us that, "after a lapse of more than four centuries, the buildings remain substantially entire to this day. The lofty hall, the magnificent chapel, the solemn cloisters, the groined gateways, and even the original doors and windows in many cases, remain undisturbed." Those words were penned more than sixty years ago, and are still true.

INTERIOR OF S. PETER'S CHURCH, SHOWING CHAIN ORNAMENT.



PLAN OF CHURCH OF S. PETER-IN-THE-EAST.

In the chapel the reredos is similar to the one in All Souls, already mentioned, though of course long anterior to it. In fact, All Souls Chapel was modelled on the one at New College. The upper small lights of the chapel and all the windows of the antechapel — except the western ones — contain original glass, and so curious are they that Messrs. Parker & Co. have published engravings of them. The tower stands on the site of one of the bastions of the old city wall, and has a belfry with ten medium-sized bells. The ringing of the bells has not affected this tower, the walls being six feet thick and of good masonry. The muniment tower, like the one at Merton, is an excellent example of a fireproof structure, five centuries old, with groined ceilings and tiled floors. New buildings for 36 students were added in 1878 by Gilbert Scott; further additions were made by Champneys; and it is proposed to further increase the accommodation when the leases of the adjoining houses fall in. These new buildings have been erected outside the old city walls, for we see in the Oxford almanac for 1844 that the site is barren.



SOUTH DOOR OF S. PETER'S CHURCH.

S. Peter-in-the-East Church. —Of all the buildings in Oxford, this church receives most adoration from antiquarians. The chief feature is the crypt vaulting of semi-circular arches, said to be of the ninth century. Above this we have the ribs of the choir, having a chain ornament which is of rare occurrence. The unique point of the church is that at the western end of the crypt there are the remains of three openings; one of these, the central one, intended for a shrine, is open, while the other

THE CRYPT OF S. PETER-IN-THE-EAST CHURCH.

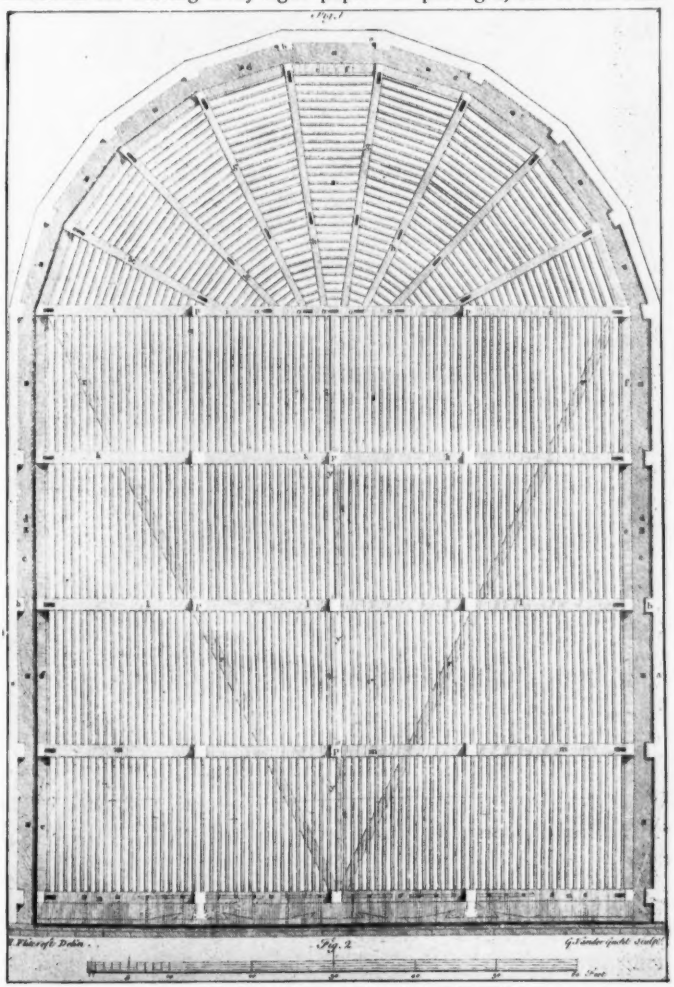
two are blocked up. In 1864 both were opened, and steps were discovered leading up into the nave. Of the present chamber, or chambers, over the east part of the chancel, little but the windows remain. This church furnishes the best example in Oxford of a room over the porch containing church warden's accounts, perhaps the oldest of any in England (1444).

Worcester College.—On entering the quad, one finds an open arcade or piazza: on the south side of the quad will be seen some of the old lodging-houses of the Benedictine Monks.

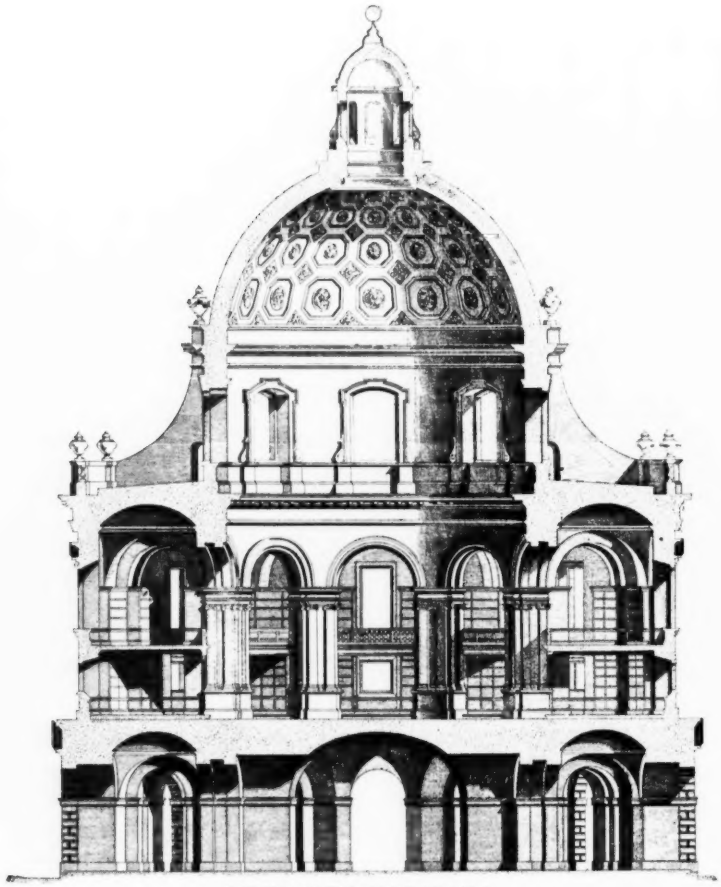
The chapel has a small dome in the centre; the intersection of the arches, and the ceiling paintings, bring to mind the Sistine chapel at Rome. The interior is very dark, partially because of creepers covering up the windows and partially because of the proximity of a building on the north side. The hall has rich panelling inlaid with the coats of arms of benefactors.

The Sheldonian Theatre.—This is an enormous space of 80 feet by 70 feet, covered in by timbers. In the "Parentalia," published by Wren's grandson, we get details of the roof, which have been specially engraved and photographed for THE ENGINEERING MAGAZINE. *a a*, walls of building; *b b*, pilasters of the rails and ballister; *c c*, lead; *d d*, pipes for water; *e e* and *f f*, wall plates and lintels; *g g*, girders of the semicircle, each supported by a king piece or crown post cut off at *h h*, and screwed into binding beam *i i*; *k k*, *l l*, *m m*, also binding beams; *o o*, prick posts let into *i i*, which also support *p p*; *q q* show the purlins between the binding beams, not set against one another because of the dragon beams or braces, *r r*; *s s*, joists; *t t*, principal rafters; *u u*, crown or king posts; *w w*, prick posts; *x x*, braces, or puncheons; *y y*, cross posts.

The painting of the ceiling is worthy of examination, recalling the method of covering the ancient theatres with open roofs; in this instance the corded moulding merely gives the impression of supporting the wide expanse of painted canvas. It is probable that the roof was intended for storing away light papers or packages, for it was con-



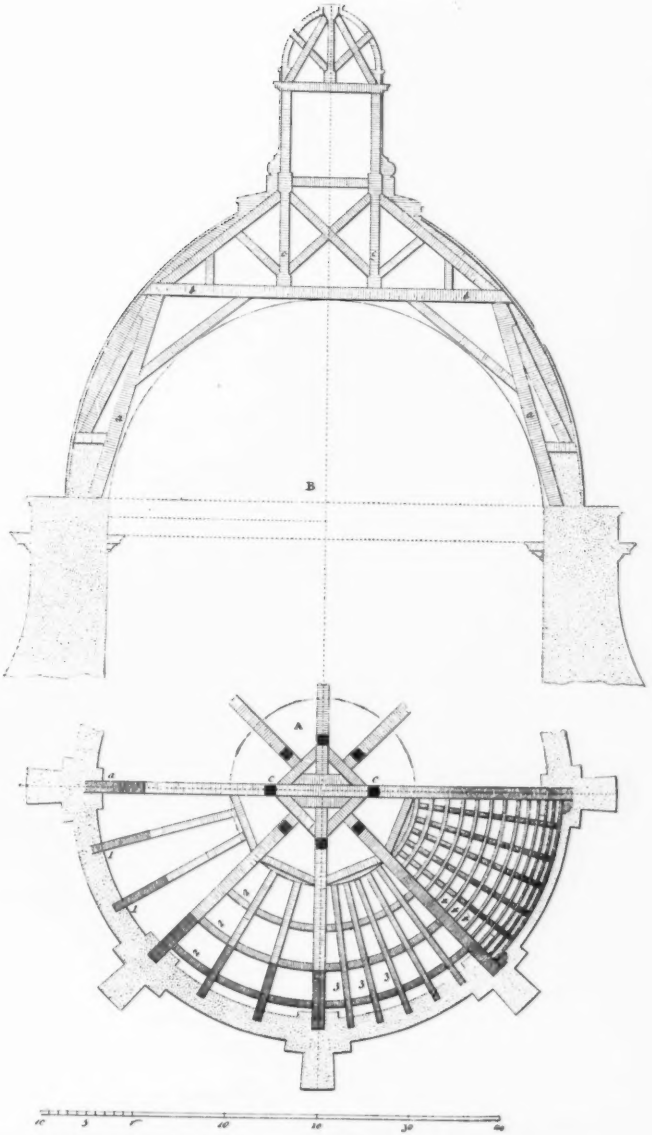
PLAN OF THE ROOF, SHELDONIAN THEATRE.



SECTION OF RADCLIFFE LIBRARY.

nected with the early printing-office of the University situated in the Clarendon building close by. The timbers, however, began to sag, and the weight had to be transferred to the basement.

The Radcliffe Library.—This is an imposing building, of which the architect, James Gibbs, has given us an account. The following is epitomised from his "Bibliotheca Radcliviana." Dr. John Radcliffe left £40,000 for building this library; it was commenced in 1737, and finished twelve years later. A vertical section and the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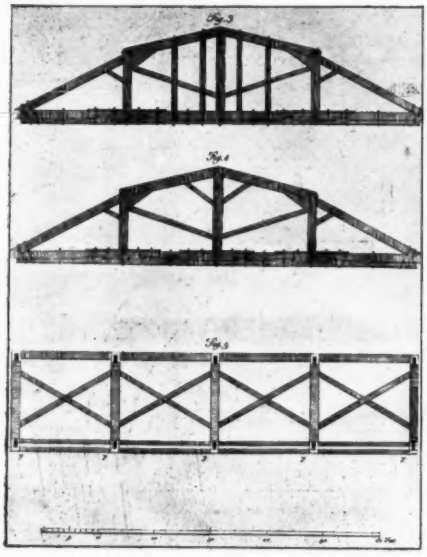


ROOF TRUSSES, SHELDONIAN THEATRE.

framing of the centering are given as illustrations. The base is a polygon of sixteen sides, 88½ feet in diameter; above this is a circular structure 48 feet in diameter, consisting of eight large blocks of masonry 6 feet by 5 feet, which carry the cupola, as also the arches over the library. The ceiling is embellished with fretwork and lighted by seven large windows and a lantern; the dome or cupola is 84 feet from the pavement. Attention is called to the railings of the staircase, which are of embossed copper.

For the centering *a a*, bearing pieces for the truss on which the lantern is framed; *b b*, beam or girder of the truss; *c c*, upright posts which form the lantern. The four divisions in the plan show the timbers which fill up the spaces within the trussed frames *1 1*; *2 2*, purlins or cross timbers; *3 3*, firring for the outline of the dome; *4 4*, the bridging on which the boards are fixed for the lead covering. The trusses are of oak, the ends of the timbers being fixed in shoes of metal to preserve them from the damp of the stone.

MACHINERY AND POWER APPLICATIONS IN THE LUMBER INDUSTRY.

By William Adams.

THE redwood forest belt of California extends along the coast range of mountains from the vicinity of the Oregon line southward about three hundred miles to the bay of Monterey. The redwood timber begins at the foot-hills a half mile to several miles from the coast, and extends back to the summit, and sometimes beyond, the width of the belt varying from ten to twenty-five miles. It is interspersed with fir of several species and with more or less tan oak, but the redwood covers most of the land. The winter rainfall is heavy on the summit—doubtless averaging more than sixty inches—and frequently falls in torrents, but there is seldom snow, and never more than a film. The streams are numerous and mostly short, the beds lying in deep cañons with steep, almost precipitous slopes. In early times logs were cut and rolled into the cañons, to be carried down to the mills by the sudden winter freshets. There were, however, but few streams where this was possible, and the timber which could be moved in this way was long since cut off. The entire belt is mountainous and deeply cut with ravines leading to the coast. The only method of getting out the logs is to get them to the bottom of the ravines, and thence out of the mountains. Occasionally, of course, there are small areas nearly level, but they are few and far between. The redwood grows to a very large size. The average diameter of the logs handled cannot be less than four feet; many logs have a diameter of eight or ten feet, and not infrequently butt logs twelve to fourteen feet through are seen. The problem of moving these enormous logs over rough mountain land, with the least possible expense and waste, has gradually developed many ingenious methods, which may be of general interest. The mill and logging camps at Fort Bragg on the Mendocino coast afford a fair example of redwood lumbering, and the methods described here are those in use in those camps, where, also, the photographs for the illustrations were taken. The methods are those developed by long experience.

The Noyo river, whose watersheds comprise the district referred to, is about thirty miles long, and has two main branches, the north and south forks; altogether the area drained is, perhaps, seventy-five square miles. In opening up a timber tract the mill is located at the most desirable landing place on the adjacent coast line, and, begin-

ning at the point nearest the mill, the timber is cut clean, and hauled in over a railroad, which is extended as the work progresses. The track, as the foot-hills are reached, is laid at the bottom of a ravine; when all the land tributary to that gulch has been cut over, the track is removed to another; and so on, until the tract is cleared off. The woods crew inhabit rough buildings hastily put up with refuse lumber, which are abandoned when the work gets too far away from them, a new lot being then put up. These successive abiding-places are called "camps," and are numbered in the order of their rise and fall.

A TWELVE-FOOT BUTT LOG.

"Camp No. 7" is situated in the bottom of a gulch, or, rather, as near the bottom as possible, for there is not a foot of level land anywhere. It is a cluster of twenty-five or thirty rough-boarded, shake-roofed cabins of various sizes, but unvaried architecture, that appear to be clinging to the steep side hill with the grim tenacity of despair. So marked is their shaky appearance that it leads one to believe that their occupants must be possessed of a clear conscience, and the philosophic nature of the stoic or the fatalist, to sleep with restful composure in so uncertain an abode. Above the camp, clear to the top of the ridges on either side, are strewn the black bodies of the charred trees; and the air is filled with the shouts of the

A BULL TEAM IN THE REDWOODS.

loggers, the rapid "puff, puff," of the "donkey-engines" and "skidders," and the ringing scrape of the saws. Further up the gulch, from out the green foliage of the uncut trees, comes the sound of the steady, sharp strokes of the choppers, interspersed at intervals by the long-drawn-outcry of warning: "Look out belo o-o-o-w!" or "up the hi-i-i-i-ll!" as the case happens to be, followed by the crash and roar of the falling tree.

The present methods of logging redwood, and the skill with which

BEGINNING A NINE-FOOT UNDERCUT.

the work is performed, have not been developed in a day, but are, like those of most other enterprises, the result of knowledge gained by experience. And this is true in no greater degree in any other line of the work than in what seems the simple act of felling.

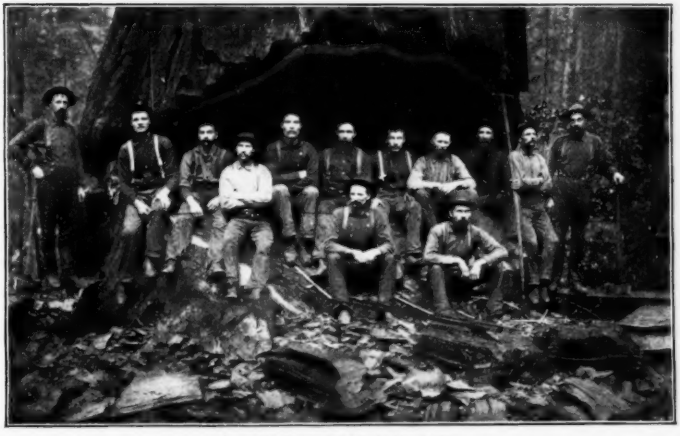
Fifteen or twenty years ago the amount of timber broken in felling was often so great that the good logs hauled away were hardly missed from the useless stuff remaining. Now, however, as the result of invention stimulated by competition, the work is accomplished with a rapidity little short of marvelous, and with almost no waste at all; a woodsman now must not only be a good axe-man and sawyer, but also be able to demonstrate his ability to "save timber," before he can procure a position as a "chopper" at the prevailing excellent wage.

The means resorted to in order to direct and control the tree in its downward flight are often most ingenious. The chopper approaches the tree, and, with the aid of a plumb line, ascertains how nearly perpendicular is its rise from its base; if the top does not lean more than two feet in the case of a large tree, or more than four in the case of a small one, he considers that he can fall it in any direction he may desire. He then views the ground, and selects the most promising "layout," and the "undercut" is made exactly facing it. If there are hollow spots in the "layout," they are filled up by felling small trees across and into them. The "undercut" usually extends about one third through, and then the tree is sawed in from the back to meet it. If the tree leans backward, a steel wedge is inserted in the saw-cut, as soon as the saw is buried in the wood, and, by frequently driving it, the saw is kept running freely. When the two

cuts are within six inches of meeting, the saw is removed, and the tree is wedged up until the top passes the centre of gravity, when it falls by its own weight, easily breaking the strip of wood remaining. It often takes two men a half-day, and sometimes much more, to wedge over a large tree.

Occasionally a tree is felled up hill, where the surface of the ground is such that it is necessary for the butt and the top to strike the ground simultaneously. To compel this, the stump is snubbed off at the undercut, which provides a slanting surface, so that the butt has no place to rest, and perforce slides to the ground. In felling on level ground or down hill, however, this is unnecessary, as a tree will always give a bound after passing a certain angle, and fall clear of the stump. If the tree needs to be rolled off to one side, half the undercut is slanted, and a pile of chips is placed on the flat surface of the other half; the result never fails to manifest the efficacy of this device. Again, by leaving one side of the uncut wood between the undercut and the saw-cut thicker than the other, the tree may be drawn considerably away from its natural course. If space permitted, numerous other "tricks of the trade" might be mentioned, but the above suffices to show what is meant by controlling the falling tree.

As soon as felled, the trees are stripped of their bark; this, too, is a greater undertaking than corresponding work with other varieties of timber. At the butt the bark is from a foot to eighteen inches thick, though, of course, it is not solid, but, like most other heavy barks, more or less fluted. Hardwood wedges, a wooden maul, and



A FOURTEEN-FOOT UNDERCUT.

a twelve- or fifteen-pound crow-bar are used for this work. The top of the tree usually peels readily, but near the butt, where the bark is thick, the work taxes a man's utmost strength.

The choppers are kept about six months ahead of the loggers, in order that the timber and bark and underbrush may become dry; then fires are set throughout the chopped district, leaving nothing on the ground except the bodies of the trees too wet to burn.

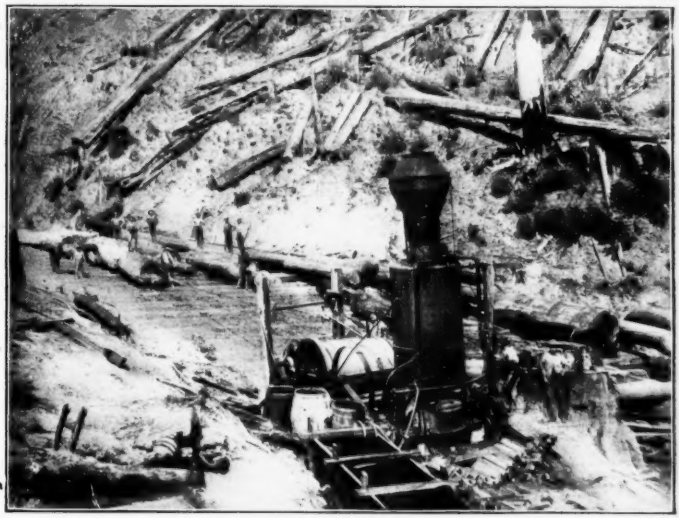
Now, again, the "cross-cutters," who come to cut the trees into logs of suitable lengths, are met by problems of their own. They find the trees lying in every direction, on hillsides so steep that goats could scarcely climb them; and the wood is so springy and the trees are so large that it is only by utilizing every advantage that any progress is made. The writer, while working at "Camp 7," was once detailed to superintend the putting out of the fires which continued to burn after the brush had been consumed. This work has always to be done; else much valuable timber would be destroyed. The top of a fine tree was discovered burning, and it was found that the only way to save it was to saw the burning part off and roll it to one side. The tree had fallen across a small gulch, so that the ends rested on the ground, but the point at which it was necessary to make the saw-cut was suspended in the air. Two stout fellows were set to sawing it, and they soon had the saw buried in the wood. It then, however, began to pinch badly; wedges were driven in the cut to spread it, but this soon proved insufficient, and ere long the saw was well-nigh immovable. We were none of us sawyers, but we all set to work and braced and propped and pried right diligently, to little purpose however; presently one of the men, utterly worn out and discouraged, threw down his tools and demanded his wages, refusing to work any longer. The next morning the superintendent of the woods sent a single experienced sawyer, and he completed the work easily.

The cross-cutters begin their work at the mouth of the gulch, and keep only a few days ahead of the logging operations. Following them come the "swampers," who clear away what brush escaped the fire, and build the roads preparatory to hauling. Along the bottom of the gulch a substantial road is built, and skidded with small logs wherever the grade is not very steep; and up each of the tributary gulches roads are built with a care proportionate to the amount of hauling to be done over them.

But it is in the hauling that the most distinctive features of redwood logging are found. For this work it has been found expedient to utilize steam power; and so, instead of the picturesque oaths of the "bull-punchers," the visitor's ear is greeted by the puff of steam and the sound of running machinery. Oxen and horses are

used only for small timber or by small mills. At the mouth of the gulch the skid-road is broadened out to form a landing from which to load the cars. It is usually large enough to hold perhaps fifteen or twenty logs, and at the lower end of this is placed a "skidder." These skidders are similar to the ordinary donkey-engines used on pile-drivers and around hoisting works, but are much larger, being of about seventy-two horse power. On them are two large drums, or spools, one just in front of the other.

From the hind drum a one-and-one-eighth-inch steel-wire cable runs up to the end of the main skid-road, and is attached to a half-inch cable, which passes through a pulley and then returns and coils around the forward drum. A string of logs is fastened together by



A SKIDDER AT WORK.

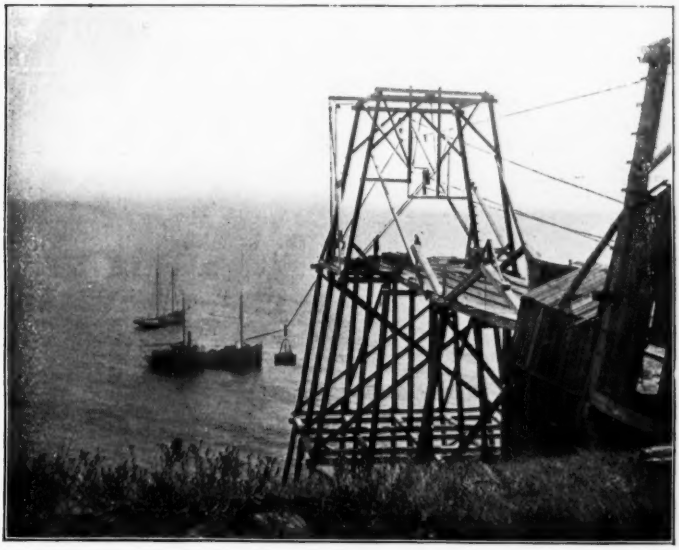
dog-chains, and then the first one is hooked to the large cable. To the last log is fastened the end of the small cable, and a sled for use in returning the dog-chains to the woods. When everything is ready, an electric bell gives the signal to the engineer of the skidder, and the string of logs, from one hundred to two hundred feet long according to their size, is dragged along the corduroyed skid-road to the landing. At "Camp 7" the cable extends up the main skid-road about a mile. Wires for electrical communication with the engineer are laid along the skid-road, and the signals are transmitted by merely breaking the wire at any point and scraping the two ends

together. The small cable is dragged back to the skidder, where it is run over its drum and used to again carry back the main cable to the end of the road.

Each skidder is supplied with logs by one or two donkey-engines of about twenty-five horse power. They are built on runners, and are made to haul themselves about by attaching them to their own cables. Instead of the large drum which characterizes the skidder, they are provided with a small spool ten inches or a foot in diameter. The surface of this spool is made very concave, so that the coils of the cable will draw together and bind when wound about it a few times. These donkey-engines are supplied with but a single wire cable about three-fourths of an inch in diameter and three hundred or four hundred feet long, having a large hook at one end.

To move the engine to its field of usefulness the "line-pullers" grab hold of the hook and drag the cable its length in the direction in which it is desired to go, and fasten the hook to the nearest stump. The "spool-tender" then takes a few turns around the spool with the other end, leaving just enough for him to pull on to draw the coils tightly together in order to make the cable bind. The engine may then be drawn up to the stump, when the line may be

LUMBER MILL, YARDS, AND WHARF AT FORT BRAGG.

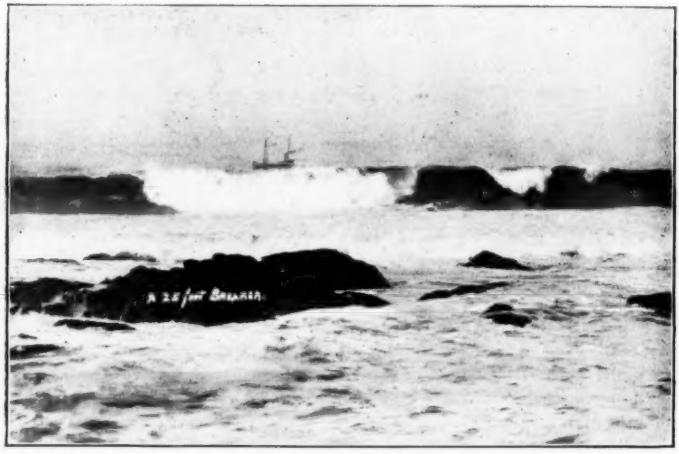


LOADING BY A STEEL-WIRE CABLE.

carried on and the operation repeated until the engine is in place. It is really astonishing to see one of these engines crawling up a steep sidehill as if it had legs. When the engine reaches its destination, it is fastened securely with guy-ropes, and then the real work begins. The line is carried out and hooked on to the logs, which are pulled out from among the stumps and started towards the main road, when they are taken up by the cable of the skidder and dragged to the landing. By passing the line through steel pulleys attached to stumps or roots, the cable may be made to pull around corners or in any direction; and sometimes, when an enormous butt log is to be moved, the line is passed through an elaborate system of these pulleys, some attached to the log and some to near by stumps, to obtain all the advantage possible. Supplementary to the donkey engine and its crew of workers are the "jack-screwers," who go along the sides of the gulches and start with jack-screws any logs which can be moved in that way; these will continue to slide or roll, when once set in motion. Where the sidehills are steep and the trees are not too large, much timber can be got to the skid-road in this way. The capacity of a skidder varies, of course, with the length of the haul, but it averages, with the aid of one donkey-engine, about seventy

thousand feet per day; with two donkey-engines, about one hundred and twenty thousand feet per day. The average scale of the logs is about one thousand feet per sixteen-foot log, but logs are frequently cut which scale as high as seven thousand feet. Three skidders and five donkey-engines are constantly at work at "Camp 7," and, in addition, they have one ten-horse team and one or two ox teams at work at the lower camps.

When the logs reach the landing, they are rolled with jack-screws and cant-hooks on to the cars, or "bunkers," as they are called, on which they are hauled to the mill. These bunkers look like half of an ordinary flat car with a big iron-shod pivotal bolster running



A BREAKER ON A PACIFIC HARBOR BAR.

across the middle of it. Two bunkers coupled together constitute a car, and the logs are loaded on them by resting one end on the bolster of one bunker and the other end on the bolster of the other. By providing coupling-irons of different lengths, the bunkers can be arranged to fit logs of any length. Much care has to be taken in loading the cars to see that the load is well balanced; else there would be great danger of mishap, for the road-beds of logging railroads are not of the smoothest, and many of the turns are very sharp. Some of the logs are so large that a single one will render a car top-heavy.

The rail road is of standard gauge, and the locomotives used are similar to the ordinary switch-engines, but are designed for this special work, being low and of simple construction.

It is rather a thrilling experience to ride from camp to mill on a

load of logs. The bunkers are not provided with springs, and long service on rough roads has somewhat inclined the engineers to recklessness. To a person taking his first ride it becomes an open question with himself whether or not he will reach the mill alive; and indeed often, as the car drops into a chuck-hole and then bounces out again, and sways far over from side to side, and pops around corners like the tip of a cracking whip, he will become convinced that it is about to be decided in the negative. Reaching the mill, the logs are dumped into a pond, whence they can be dragged as needed.

The mill at Fort Bragg is one of the largest and most complete mills on the Pacific coast, and is designed not merely to convert the logs into rough boards and timbers, but to provide the market with every product of lumber. In fact, there are many practical millwrights who contend that the mill is so overburdened with complicated machinery as to occasion much confusion and consequent waste.

The mill has two main saws,—one of the double circular type, having a six-foot cut, and the other a band-saw capable of cutting a log ten feet in diameter. When the logs are more than ten feet in diameter, they are split in two by putting a small blast of powder in the side of them before they are brought into the mill.

To rip up the cut which leaves the main saw, a "gang" edger is used; it is fifty-six inches wide, and will cut a slab eight inches thick. It contains six saws that can be shifted at will to cut any width of board. From the edger the lumber is carried on rollers to the lumber-yard or to the surfacer, where it is converted into the finished product in its various forms. There are also shingle and lath machines, etc., each of which produces quantities of its particular specialty. About one hundred and twenty-five thousand feet of lumber is an average day's work for this mill.

This vast amount of machinery is run by two common slide-valve engines of seven hundred and seventy-eight horse power each, which are of heavy construction and rigidly plain.

The mill is built a short distance from the water's edge, so that lumber can be loaded on hand-cars and run out to the wharf; a gentle downward slope of the track greatly facilitates this proceeding. From the wharf the lumber is picked up with a derrick, a thousand feet at a time, and swung over on to the vessel as fast as it can be stowed away. A double-cylinder hoisting engine is used for this purpose, and the apparatus is capable of handling five hundred thousand feet of lumber in twelve hours.

The Fort Bragg harbor, while one of the best on the Mendocino coast, is not by any means an ideal one. The water being shallow, the harbor is accessible only to vessels of light draught, and to attempt

to enter the narrow, crooked channel, lined on either side with treacherous rocks, is an exceedingly hazardous undertaking in stormy weather.

For loading deep-sea ships the lumber must be taken about a mile to the mouth of the Noyo river, where the depth is sufficient, although the harbor is not so well protected. The method of loading at Noyo is the one now generally adopted where the sea coast is bold and where wharves cannot be maintained, but possibly it is not used anywhere on the Atlantic coast. The work is accomplished by means of a steel-wire cable stretched from the high bank to the vessel. A pulley-wheel, called a "traveller," is run on this cable, from which is depended the load of lumber in a sling of chains. The force of gravity carries the load to the ship, and then the traveller is hauled back by a donkey-engine. About one hundred and fifty thousand feet of lumber per day can be loaded at Noyo in this way. This cable method of loading is the most common along the Mendocino coast, as there are very few points where the harbor is sufficiently sheltered for a wharf. Indeed, in many cases there is no harbor at all, but the cable is run directly out to the open sea.

It has been recently estimated that seventeen billion feet of redwood lumber remain yet to be cut; under present conditions it will last thirty to forty years.

To one visiting these great logging camps and mills, the like of which do not exist elsewhere, perhaps the greatest impression carried away is of the wanton, needless, almost criminal waste of wood and lumber. The only idea which appears to actuate the lumbermen is to utterly obliterate these magnificent forests as speedily as possible. It seems hardly right that two or three generations shall be permitted to dissipate in a few short decades this splendid heritage. In spite of the ravages of axe and fire, the redwood, when cut, does not die. From the roots there at once springs up a dense miniature forest, which within twenty-five or thirty years produces trees that anywhere else would be considered of good size. This second growth, however, is brittle and knotty, partly because of the dense growth compelling dozens of sprouts to struggle for the sap from one stump. If these sprouts could be judiciously thinned out from year to year, and the strength concentrated in a number of trees no larger than that which originally occupied the ground, the quality of the second crop would be greatly improved. Present owners might do this, if only the cost of thinning had to be considered; but that would be a trifle compared with the expense of protecting from fire for the first ten years. With that to be considered the owners will do nothing. Some plan should be devised for so conserving what is left that posterity may get as much as possible out of it.

THE EVOLUTION OF SAFETY IN RAILWAY TRAVEL.

By Charles Hansel.

THE engineer is the pioneer of modern civilization, not only in opening new parts of the earth for settlement, but in leading the progress, developing the resources, and increasing the comforts of older regions.

The industrial systems of the great progressive nations stand as an expression of his genius, larger even than the concrete embodiment presented in their products. But probably no manifestation of his work is more impressive, in extent, dignity, diversity, or economic influence, than the great transportation systems which are breaking down national isolation and mingling the thought, as well as the substance, of different lands.

Advance may be rhythmic, rather than unbroken—or, rather, while advance continues, its expression may change.

The progress of one generation may even appear the obstruction of the next; this is vividly illustrated in the evolution of commerce between Liverpool and Manchester, the example being taken as illustrating the progress of transportation and the birthplace of the railway.

Manchester, situated on the Irwell, finds in Liverpool, on the Mersey, its natural port. The first organized scheme of transportation between these two points, and perhaps the first in England, was known as the Irwell and Mersey River Navigation Company. The system of carriage was navigation of the Mersey and Irwell rivers. In 1757 the population of Manchester and its environments was only 20,000. The imperfect state of the roads and the uncertainty of travel by river rendered it difficult and exceedingly expensive at some seasons for so large a population to provide themselves with food and coal. There was no connection between the collieries situated at the east of Manchester and the Irwell or Mersey, and the charge for cartage between Manchester and Liverpool by the Irwell and Mersey River Navigation Company was no less than forty shillings a ton.

These conditions existed when the duke of Bridgewater commenced the building of a canal from Worsley to Manchester, which was the beginning of the enterprise that gave Manchester its first certain connection with Liverpool, and was the first of England's navigable canals. The completion of this canal to the tidal estuary of

the Mersey was naturally impeded by the opposition of the Irwell and Mersey River Navigation Company, which saw its monopoly assailed in this new method of transportation. Notwithstanding this opposition, the canal was opened in 1773, establishing water connection between Manchester and Liverpool,—a truly magnificent undertaking, nobly planned and skilfully executed; although in the early stages of construction the people called this canal "The Duke of Bridgewater's Folly," the financial returns established its value as a commercial enterprise, and showed from the first the necessity for building it.

The business of Manchester increased so rapidly with the opening of this canal that it was found necessary to provide additional means of transportation to Liverpool. Cotton lay at Liverpool for weeks, awaiting shipment, and it frequently required more time to transport cargoes from Liverpool to Manchester than from the United States to Liverpool. The canal was overcrowded with business, and the charge for carriage between Manchester and Liverpool had been reduced from forty shillings per ton to eight shillings, and the poor, decayed town of Liverpool of Queen Elizabeth's time had now become the principal seaport of the kingdom. This marks the second epoch in organized transportation.

We find that, when the duke commenced the construction of his canal, he had to contend with the fierce opposition of the Irwell and Mersey River Navigation Company, which at that time had the monopoly of transportation beween these two cities. The completion of the duke's canal placed him in the position of chief conspirator to secure the good of the community, commonly called a monopolist, and, as the increased commerce overflowed the channel of his canal, there appeared upon his horizon the dawn of a new era of transportation, which marks the third and most important epoch in this history of internal improvement.

At Edge Hill in October, 1829, there gathered a crowd to witness the triumph of the "Rocket" of Stephenson over the "Novelty" of Ericsson, the "Sanspareil" of Hackworth, and the "Perseverance" of Burstall. No throng at Doncaster to witness the St. Leger has ever equalled the gathering at that iron track to witness the performance of a power that now tallies the miles by the second hand. It is interesting to note that the "Rocket" of that day possessed all the principles of the express locomotive of to-day. We refer to the tubular boiler, forced draught, outside-connected horizontal cylinders, and the reversing mechanism.

The duke of Bridgewater was compelled to fight his canal through parliament against the prejudices of the people; he in turn became

a monopolist, and the third epoch marks Stephenson, with his "Rocket," pointing the way to the new era of civilization. Opposed to him we find the progress of the preceding generation headed by the duke of Bridgewater, and, when Stephenson proposed to carry persons at the astonishing speed of twelve miles per hour by using the locomotive, the opposition and prejudice met by the duke of Bridgewater was multiplied by the opposition of nearly every individual. He stood alone, in contradiction of the best judgment of the foremost engineers of his time, and, without the monument of previous success to sustain him, but by his genius and perseverance, he planned and constructed the first iron highway between Manchester and Liverpool, which has expanded to not less than 555,500 miles, bringing the people and nations of the world together. The cost of carriage has been reduced from eight shillings a ton (on the duke of Bridgewater's canal) for the thirty-five miles between Manchester and Liverpool to less than one shilling a ton on the fourteen lines of railroad connecting Manchester and Liverpool.

Great Britain, with an area of 89,222 square miles, 58,320 of which are in England and Wales, had, at the time the first railway was opened, a population of 16,400,000. The cotton, woolen, and silk mills of Lancashire, Middlesex, Surrey, Kent, Gloucester, Hereford, Yorkshire, and many other manufacturing centers were busy with a great industry. More than two hundred silk mills were in operation, and the looms of Manchester alone consumed 264,000 pounds of cotton, most of which came from America. The shipbuilding on the Clyde and the steel and iron mills of Leeds and Sheffield were then great industries, and there were 2,300 miles of canals in successful operation.

The first railroad engineers of England followed their profession at great personal danger, owing to the fierce opposition of the English country gentlemen to innovations in methods of conveyance and the superstitious prejudice of the commoners, and this feeling of local opposition was also an important factor in the heavy cost of construction, as every foot of right of way was purchased at a conciliatory figure, or condemned by process of law which resulted in exorbitant values. But, while the building of railways in England was attended by great cost, it was assured abundant patronage from the great manufacturing industries, whose product then overflowed the existing channels of commerce.

The preference of the commoners for the slower and more familiar methods of transportation by canal and stage, founded on superstition and supposed self-interest, made it necessary for the railways to offer special inducements to secure traffic which had heretofore fol-

lowed the canal and stage, notwithstanding the fact that the railway offered cheaper and quicker transportation and the business of the country was overcrowding existing channels. As a means of inducing the people to favor this new mode of transportation, the railways offered to cart freight free of charge to the shipper, and this concession to the more primitive means of transportation has resulted in a branch of railway service in Great Britain which is found nowhere else. It has compelled railways to build immense warehouses, purchase thousands of draught horses with their attendant carts, harness, etc., and build large stables and veterinary hospitals; and, as an illustration of this branch of service, unknown in the United States, one railway operating but five hundred miles is required to employ at one important freight terminal twenty-one hundred men and eight hundred horses, made necessary by the free delivery of freight to and from their patrons and the warehouses.

The United States of 1830 numbered twenty-four States, the District of Columbia, and the three territories of Michigan, Arkansas, and Florida, with a total population of less than thirteen millions, of whom two millions were slaves. The vast territory west of the Mississippi was unexplored, and the railway development in the United States has had to adapt itself to a new and rapidly-developing country. While the American engineers were not attacked by the commoners or obstructed by the nobility, they found greater difficulties, for they were compelled to accomplish their surveys and construct the railways through a country inhabited by a savage foe. Moreover, instead of finding an ample commerce ready for the railroad, it was necessary to foster new industries and wait for their development.

Notwithstanding the great obstacles to the location and construction of the railways, there have been built in the United States, since the opening of the South Carolina Railway of 1830, no less than 186,500 miles, the construction of which has employed hundreds of thousands of men and hundreds of millions of money, and has brought the charge for carriage to less than one-half a cent per ton per mile.

Looking eastward, we see in "Darkest Russia" the construction of the great Trans-Siberian and Manchurian railways, bringing the capital on the Baltic and the Holy City of Moscow to the Japanese sea at the port of Vladivostok, and to the ice-free Yellow sea at Port Arthur, crossing the border line between Siberia and China at Stretinesk and making the ports of Vladivostok and Port Arthur an integral part of the great Russian empire.

Coincident with the extension in mileage has been the improvement in condition, in management, and in speed and safety of travel. The equipment of trains for passenger service in the United States is

more luxurious than that of any other country, and the comfort and security assured to the traveller remove from his mind all thought of danger.

It is not sufficient to provide luxurious equipment and commodious passenger stations, and it requires much less expenditure to perfect this branch of the railway service than to furnish a permanent way safe for the passage of trains at tremendous speed. The luxuries of yesterday become the necessities of to-day, and safety appliances which by many were considered luxurious refinements are the means by which railway travel has been made safe.

The safety of railway travel is emphasized in a practical way by the action of the several insurance companies of the United States, which have found that the danger incident to railway travel, or travel on any common carrier, is so minimized that they offer policies providing for the payment of twice the amount if the holder is injured or killed while travelling by any common carrier.

The statistics for the past twelve months show that the railways of the United States carried 550,000,000 passengers, that one passenger was killed for every 2,250,000 carried, and that one was injured in every 4,500,000 miles of travel.

The locomotive taught us how to go, and the air brake taught us how to stop, and it was soon found of equal importance to know when to go and when to stop. This necessity has brought about a new field in the industrial art, and has established a profession called "signal engineering," which has become an important department of railway service. Railway officials who have won position by faithful and intelligent service, guarding alike the interests of the public and the property in their charge, and having a clear insight into the multifarious interests and the safe and successful conduct of their business, are the first to acknowledge the necessity of guarding every point of danger. It has been found necessary, however, to aid them by invoking the power of the law to compel railways to adopt certain approved appliances for protection of life and property; and, since the necessity of being able to stop and of knowing when to stop is the first requirement of safe operation, federal and State legislation has been enacted in the United States, requiring the adoption of the air brake and signaling devices for the guidance of the engineman and trainmen.

The introduction of the air-brake, perhaps the most important safety-appliance in railway operation that has been designed and perfected, solved the problem of how to stop. But it is not necessary to explain its operation, the general principles whereof are understood by the travelling public.

When the Liverpool & Manchester line was opened, the speed of trains was limited to twelve miles an hour, although the "Rocket" demonstrated its ability to travel thirty-five miles an hour with three coaches. The first scheme for guarding against collisions was the introduction of a horseman armed with a flag who preceded the train; after this came guards stationed at intervals along the track within visual distance, whose duty it was to notify the approaching train, by hand signals, that the preceding train had passed the next station.

As the speed of trains increased, it was found unsafe to rely, as formerly, on the flag or lantern in the hands of men stationed along the line. It became necessary to devise means of advising the engineman what to do, in language admitting of but one interpretation, —stop or advance. Moreover, the message must be given in advance of the approaching train, and, once given, it must be beyond the power of the signalman to change it until it has fulfilled its office.

While it is desirable to separate the grades where one railroad crosses another, it involves great expense, and interferes with the convenient interchange of business. For these reasons we find that in the United States the majority of crossings are made on a common level. The principal dangers of railway operation, outside of the physical condition of the permanent way, are found in the crossing of the tracks of one railway with another at the same level, the junction of one railroad with another, the collision of trains on the main track, the crossing of navigable streams requiring a drawbridge, and the introduction of passing tracks. Since no official public reports are made on the accidents which occur in the United States, it is impossible to illustrate the value of protecting these points of danger by a suitable system of signals, but that such protection is necessary is conceded by all railway-operating officials.

The police regulations in the majority of States require that a train shall come to a full stop within a certain distance of any crossing or junction before proceeding over it; if this law was observed, there would be little danger of accident at grade-crossings or junctions. But such stopping entails an operating expense, and is the source of much delay and annoyance. Consequently trains pass over these crossings at high speed, at the risk of a heavy penalty. It has been demonstrated that all crossings, junctions, drawbridges, and passing tracks can be completely protected against collision or accident, and consequent loss of life and destruction of property, and that this protection not only facilitates traffic, but materially reduces the cost of operating; and thus, aside from the desire to protect human life, the possibility of saving time and cost offers a sufficient inducement to the railways to introduce these safety-appliances.

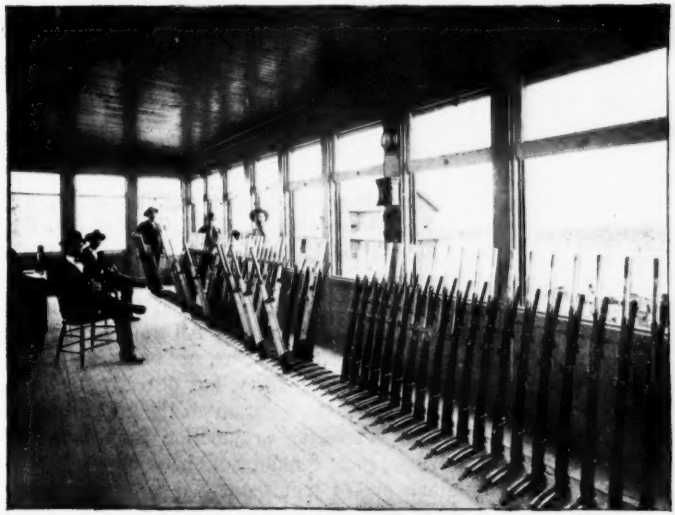


FIG. 1. OPERATOR'S FLOOR IN A 68-LEVER SIGNAL TOWER AT SHORB, CALIFORNIA.

Several of the States have enacted laws providing that, if a railroad crossing at grade, a junction, or a drawbridge is protected with signals which make it safe for the railway to operate trains over such points without first coming to a full stop, the trains may be so operated, and the law requiring them to stop at such grade-crossing is declared inactive as to the particular crossing, junction, or drawbridge so equipped. The methods of designing and installing a suitable system of signals for the protection of crossing, junction, drawbridge, or passing track, while differing in detail, necessarily involve a universal principle of safety, which may be described as follows: a system of operating switches, crossings, and signals in such a manner as to make it impossible for the signalman to bring about an accident by careless or ignorant manipulation.

Without going into details, it is sufficient to say that all switches and signals within the limits of a defined area are controlled by a machine at a central point in charge of a signalman, and that the operating mechanism in his charge is so arranged as to require him to operate the signals in proper sequence, the result being that he cannot give signals which will authorize an engineman to proceed where there is any possibility of collision with a train on the opposing route.

The mechanism which enables the signalman to control these switches and signals is located in a signal cabin at a convenient

point, generally near the crossing, junction, or drawbridge, and the principle upon which it is operated is similar to that of a combination safe-lock, requiring him to manipulate the machine according to a predetermined plan. In case he fails to follow this plan, he may delay traffic, but cannot cause an accident.

Fig. 1 is an illustration of the interior of a signal cabin, showing the levers by means of which the operator is placed in direct connection with and control of the several switches and signals. The interlocking mechanism by which the movement of these several levers is controlled is below this floor. This signal cabin is located at Shorb, Cal., a very important junction point on the Southern Pacific, within a few miles of Los Angeles. There are sixty-eight levers, and by them all the switches and signals are operated. All train movements are made at this point without switch-tenders, not only facilitating the movement of traffic with absolute safety, but also avoiding the danger of accident to employees. In addition to the safety secured by operating all switches at a crossing or junction from a central point in the manner described, great economy of operation is effected, especially at busy terminals and at points where the gradient of the road is such that, if trains were compelled to stop for the crossing, it would not be possible to draw trains as heavy as those which can be drawn without stopping.

Fig. 2 illustrates the entrance to the passenger station of the Union Railway at Troy, N. Y. The signal cabin in the foreground, located on a steel bridge spanning the tracks, controls all switches and the signals indicating their position for the entrance of trains into the station. A similar cabin is installed at the opposite end of the station, and these cabins are so connected as to require harmonious action on the part of the signalmen in charge. There is an ascending gradient to the north. This system of signaling renders it unnecessary for a freight train to stop on this grade, and, consequently, heavier loads may be carried, while at the same time traffic is moved with greater speed and absolute safety. The signals for trains leaving the station are carried on a bridge across the portal of the train-shed. In the illustration all signals are in the danger position, except the upper arm of the right-hand signal at the signal cabin on the bridge. This position indicates that a north-bound train on the ascending grade has right of way, and all opposing trains are blocked against it.

The control of a drawbridge with a grade-crossing near the end of it is illustrated in Fig 3. The Illinois river is crossed at this point by a bridge about one thousand feet long, including a draw span of three hundred and fifty feet. The danger to traffic at this point is unusually great, as the trains of six companies are compelled to cross

this bridge to secure entrance to Peoria. An interlocking plant has been established at this crossing, which not only controls the movement of the drawbridge, but provides that, when a train has received a clear signal to advance over it from either end, no opposing train can reach the crossing; nor can the engineman on the drawbridge operate his engine or unlock the bridge, until the entire train has passed over and beyond the crossing.

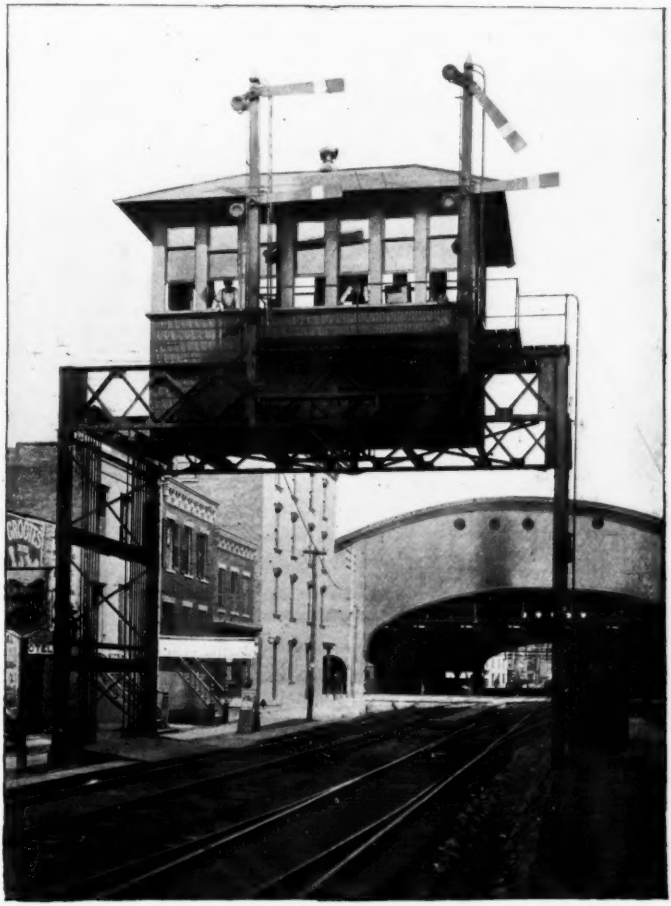


FIG. 2. SIGNAL TOWER PROTECTING A THROUGH STATION. TROY, N. Y.

While the crossing of two street railways is not as hazardous as a crossing of two steam railroads at grade, and while the crossing of a street railway with a steam railroad may not be considered as hazardous as the crossing of two steam railroads at grade, it must be held that the crossing of the tracks of two or more lines of railway, be it of a steam railroad with a steam railroad, or of a steam railroad with a street railway or other secondary railway, must ever present great danger to human life, unless so protected as to make it impossible for trains or cars on either road to reach the crossing at the same time. The present tendency is to increase the number, as well as the mileage, of existing lines of street railways throughout the United States, which cannot be done without crossing and recrossing the tracks of existing steam railroads.

FIG. 3. SIGNAL SYSTEM PROTECTING A DRAWBRIDGE.

The same general appliances may be used for all railways at grade, no matter what the motive power. An additional safeguard may be secured where a steam railroad is crossed by an electric street railway, by so arranging the mechanism that the current is cut off from the electric car at a distance from the crossing, so that, if the motorman fails to see that the signal is against him or disobeys it, he cannot reach the crossing, the car having no power.

The method of guarding against the collision of trains on the main track where there is no crossing or junction is almost the same as that used for the protection of grade crossings or junctions, the difference being that the mechanism for controlling the signals which

govern the movements of trains is so involved with the signal cabin on either side as to require the co-action of two signalmen at points some distance apart in order to clear a signal which will give a train authority to proceed over the track between the two signal cabins. By requiring the united action of these signalmen at both ends of the section of track, protection is secured against errors which might occur if the signals were in the control of one man; the signalman receives definite information as to the movement of trains at either side of his station, and, in case he has authorized the train to advance to the next signal cabin ahead, he is not at liberty to give the same authority to a second train without the consent and co-action of the signalman in advance, which cannot be given until the first train has passed the cabin in advance, thus making it safe to issue an order for the second train to advance. By this means the trains are divided by space, and the maximum safety is secured.

The yearly record of train accidents shows that a large percentage of the loss of life and property is directly chargeable to "open switches." While it is possible in many cases to avoid the use of facing point switches on double lines, it is impossible to pass trains and serve industries on single-track lines without introducing this danger. These facing point switches are often made necessary by the requirements of passing sidings, and, as the word implies, the necessities of the traffic require these sidings, so that trains may be passed at such points; consequently it is expected that these passing sidings will be frequently occupied by a train, and, unless some provision is made whereby the switches from the main track will surely be closed and locked for the main track after a train has passed through into the siding, the approaching train will follow into the passing track, and a collision will occur.

The cost of protecting against this class of accidents as compared with the cost of installing a system of signals for the protection of grade-crossings or junctions is exceedingly small; as an example, twenty-five or thirty facing point switches may be protected at the cost involved in the protection of the simplest grade-crossing. There is no additional fixed charge for operating the protection installed for the facing point, whereas the operating cost of protection for the simplest grade-crossing is not less than $900 per annum. It therefore seems that, while the revenues of small railroads may not be sufficient to warrant them in installing signal plants for the protection of all their grade-crossings and junctions, there is no good reason why they should not protect and guard against accident at all facing point switches.

MINING THE IRON ORES OF ARCTIC EUROPE.

By David A. Louis.

IN connection with the meeting of the British Iron and Steel Institute, held at Stockholm last autumn, a most interesting excursion was arranged, by the Gellivare Mining Company (Aktiebolaget Gellivare Malmfält) of Stockholm, with the object of enabling a selected few to visit, inspect, and become personally acquainted with, the hyperborean iron deposits of Sweden, the operations connected therewith, and the associated circumstances and conditions.

The journey northward from Stockholm as far as Gellivare, a distance of eight hundred and twenty miles, was made enjoyably and leisurely in one of the comfortable sleeping-cars of the Swedish State railway, attached to an ordinary train. These north-going trains do not travel during the night, but stop the first night at Ånge and the second at Jörn,—an arrangement that renders sleeping in the cars agreeable. The journey, under these easy conditions, occupies fifty-six hours, and gives travellers an opportunity of seeing the country and verifying the geological map of Sweden for a considerable area. The country passed through is, as depicted, a general expanse covered with glacial and post-glacial deposits of peat-logs, clay, sand, gravel, and boulders, with an outcrop of granite or other crystalline archæan rock at very rare intervals. The resulting landscape is very pretty, if not very varied, and consists of nicely-wooded hills with intervening stretches of rolling, or flat, or marshy country amply provided with lakes, many picturesquely studded with fertile and wooded islands; moreover, the railway crosses (in some cases by notable bridges) nine considerable rivers, each adding a charming variant to the scenery, while the Arctic circle, crossed just before reaching Polcirkeln, a little more than forty-three miles south of Gellivare, lends a sentimental factor to the interest of the journey. The continuation of the line is projected from Gellivare to Victoriahavn on Ofoten Fiord in Norway,—a port that is open all the year round. This will serve the two great iron ore deposits at Kiirunavaara and Luossavaara, which, in fact, constitute the main cause of the extension.

The colossal deposits of iron ore at Gellivare, Kiirunavaara, and Luossavaara are situated in the province of Norrbotten, in Lapland, which, moreover, boasts of other deposits at Routivare, Svappavaara, Kilnavaara, Altavaara, and Kurravaara, shown on map (Fig. 1). But of all of these the first one alone is being exploited, it having railway communication with a port,—Luleå,—which the others have not, and therefore it will be the first to receive detailed attention.

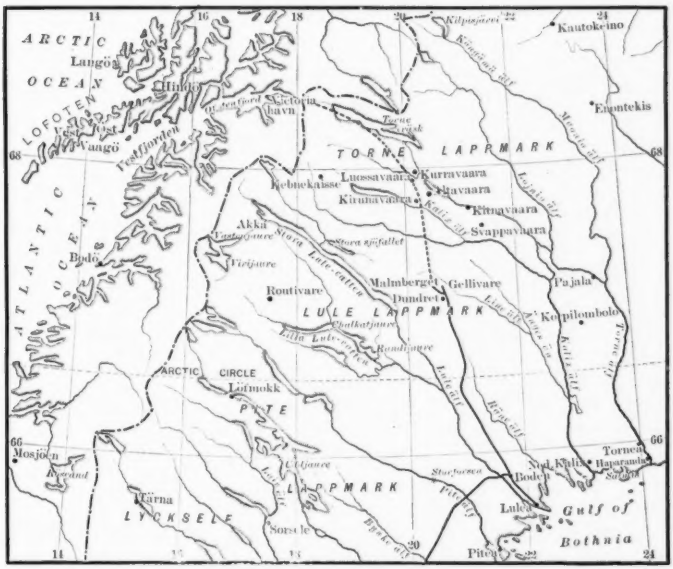


FIG. I. MAP OF THE IRON REGIONS OF SWEDEN.

These deposits are mostly characterised by the association of more or less apatite with the iron ore in which they occur, outcrops of archæan rocks as lenticular, bedlike masses, of which the horizontal sectional area has been ascertained to be as follows: Kiirunavaara-Luossavaara, 516,000 square yards; Routivare, 360,000 square yards; Gellivare, 240,000 square yards; Svappavaara, 45,600 square yards.

The horizontal sectional area of the deposits at Grängesberg is 108,000 square yards; at Norberg, 36,000 square yards; at Dannemora, 14,700 square yards; all others, of less magnitude. And the results at Gellivare show that the Norrbotten deposits are not going to take an inferior position when the yielding capacities are compared.

These deposits are by no means new discoveries, for they—at least, the Gellivare deposits—are referred to in an official report dated 1704. Moreover, projects for working them have been numerous; as far back as 1735 Lieutenant Tingvall obtained a concession for working the Gellivare deposits, and in 1735 received permission to erect a blast-furnace. He was a wise man in his generation, and turned his rights over to a company in 1742. But these and subsequent operations of the last century were of a very limited character,

owing to difficulties of transport; anyway the deposits had become celebrated, and, by the end of the first quarter of this century, nearly all the ore-bearing ground had been taken up; but, in spite of this, the industry did not thrive. The work required to keep the concessions going was not done, and consequently the whole district came back into the hands of the crown. Since 1860, however, it has been in the keeping, first, of a Swedish-Norwegian syndicate; then of Anglo-Swedish companies, which did a considerable amount of useful work, especially toward the construction of the Gellivare-Luleå railway. The beneficial results of their operations are even now abundantly evident; but somehow the alien company was not regarded with great favor by the patriotic natives and their government, and various difficulties were encountered from this and other sources, that together rendered the efforts of the British companies unsuccessful, and the last of them came to an end in 1887, in which year Col. C. O. Bergman acquired the mines. The railway to Luleå was completed in the next year, and in 1890 the property was transferred to the present company, which was founded in that year by Consul G. E. Burns, who is still managing director and principal share-holder, and who has acquired for the company a large interest in the deposits further north and been largely instrumental in bringing to a satisfactory conclusion the negotiations connected with the railway extension to Ofoten. This extension, originally one of the objects of the British Company, has now received the approval of both the Swedish riksdag and the Norwegian storthing and, it is expected, will be complete in four years. In the meantime ore from Gellivare is transported to Luleå, a distance of some 130 miles, and, as the railway is under the control of the government, favorable rates are allowed to the Swedish company. Moreover, mining is now done systematically. The ores are carefully graded, and the quality of the graded ores is checked by analysis, so as to guarantee the quality of the exported material. It is not therefore surprising to find the annual export of ore very considerable in spite of the fact that the port of Luleå is frozen up for seven months in the year. The exports for the last six years and the present year are:

1892.....139,194 tons.	1895.....384,007 tons.
1893.....260,754 "	1896.....614,262 "
1894.....525,728 "	1897.....815,797 "

1898..... 804,732 tons.

The present appearance of the town of Gellivare and of the country around it, looking northeast, may be gathered from Fig. 2. As will be seen, it is a modern, or modernised, place, with houses scattered here and there without any semblance of order. The river is the

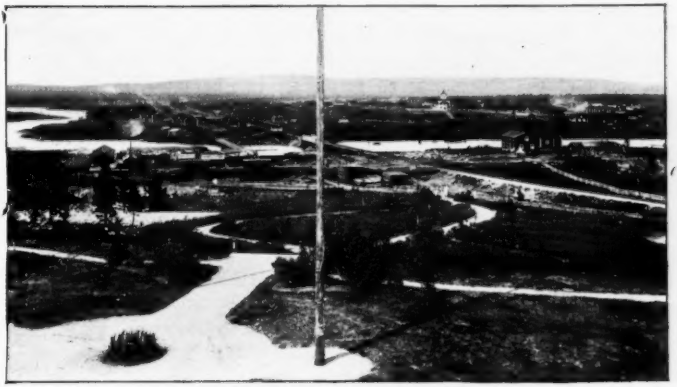
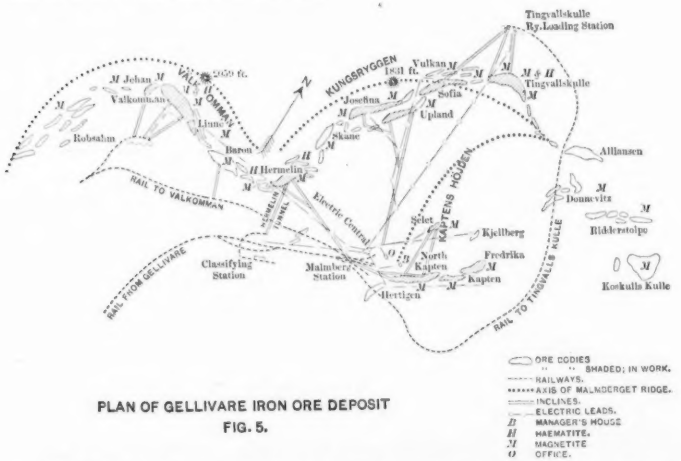


FIG. 2. GELLIVARE AND ITS SURROUNDINGS.

Vasara ; the heights in the distance are those of Malmberget, to which the railway runs ; it is some four miles distant, and is the home of the Gellivare iron ore deposits. A view of the hill and camp of Malmberget looking northward is given in Fig. 3. The tall chimney shaft on the left is that of the electric power station ; the building near the centre, above which the flag flies, is that in which the offices are situated ; just over the roof of that building is the great incline from Josefina and Upland mines. The house to the extreme right is that of the hospitable manager of the mines, Mr. Bosaeus, and is

FIG. 3. MALMBERGET CAMP, LOOKING NORTH.

situated on the rising slope of Kaptenshöjden. The town of Malmberget, in appearance, calls to mind the mining camps of the western States, with the exception that the streets are not so regularly arranged and the stores not so imposing in character, for Malmberget's great stores resemble more an oriental bazaar. The saloon, too, is wanting, or is only a very dreary presentment of a western American saloon; in fact, there is a good deal of temperance in these northern districts. Malmberget has risen only with the mines, but has now six thousand inhabitants.



PLAN OF GELLIVARE IRON ORE DEPOSIT
FIG. 5.

The plan (Fig. 5) sets forth the orientation of some of the Gellivare iron ore deposits; they are very numerous, and are covered by almost one hundred and fifty claims. They form a broad broken chain of scattered deposits, of irregular form and magnitude, taking a serpentine course of about three miles in length in an outcrop of gneissic archæan rock, the axis of which is shown by the dotted line on Fig. 5, but which has a general trend northeast and southwest with a spur, Kaptenshöjden, to the eastward, separated by a valley. There are large deposits of ore both below the surface of the valley and cropping out on the hill. The main axes of the separate lenticular masses follow approximately the general curvature, so that some run north and south, some east and west, a few—"Vulkan," "Tingvalls Kulle," "Kapten," etc.—northeast and southwest, while others are even curved, such as "Hermalin," "Josefina," and "Sofia."

The highest point of Malmberget, which means "the mountain of ore," is at the western end, and is known as Välkommen. It is

2,059 feet above sea level and 670 feet above Malmberget station, and is continued eastward as a ridge, known as Kungsryggen as far as Tingvalls Kulle. The mountain is precipitous or steep on the north side, but forms a series of terraces on the south side, on which side all the deposits, except "Tingvalls Kulle" and the greater part of "Sofia," are situated. The ore bodies all dip to the south, but at different inclinations, varying from 40° to 80°. The deposits are mostly owned and mined by the Gellivare Company; but there are other proprietors, notably the Witkowitz Company, of Moravia, who own the most easterly deposits. In Fig. 5 the shaded areas indicate the deposits being worked; M indicates magnetite and H hæmatite, but I have not shown all the unworked deposits.

The mining is almost entirely open cast, and is similar throughout the whole neighbourhood; but both the methods of working and the character and aspect of the deposits will best be gathered from the series of photographs reproduced here, which represent various views in the chief mines and will be referred to in dealing with those mines.

FIG. 6. WORKING FACE IN THE KING OSCAR MINE.

Starting from the northeastern extremity of Malmberget,—that is, at Tingvalls Kulle—one of the largest mines is encountered, known as King Oscar mine; Fig. 6 shows a working face in it. The deposit here consists mainly of magnetite, but there is also a considerable amount of hæmatite and apatite. At the outcrop it was 670 feet long and from 27 to 337 feet in width, and had a total area of 21,600 square yards. This is now represented by a vast excavation of the

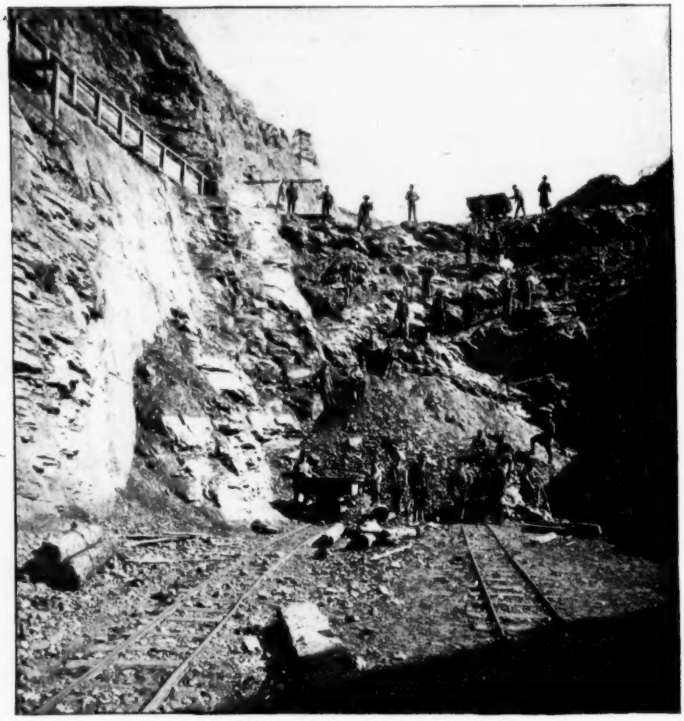


FIG. 7. WORKINGS IN THE HERTIGEN MINE.

dimensions indicated and from 70 to 120 feet deep, teeming with men and boys and resounding with the ring of the hammer and drill. Work was started at this mine in 1893, after the completion of the railway extension from Malmberget station to Tingvalls Kulle. This extension is 3½ miles long, and at its terminus is 370 feet below the top of Tingvalls Kulle; it is shown on the plan (Fig. 5) curving round to the east and northeast.

The method of working adopted here is the same as that employed, with slight modifications, throughout the Gellivare mines. The ore is mined open cast, and the broken ore is drawn out at the bottom of the working through a cutting, or through shorter or longer tunnels, as the case may be. In a very few instances ore is drawn up an incline out of workings not yet provided with other means of egress. The first level is generally made at a depth of from

60 to 70 feet, and, while the clearing-out of this section is going on, a shaft is sunk from the floor of the level in the ore, and a daylight tunnel is driven in from the hillside to meet this shaft at a depth of one hundred feet or so. The mass of ore intervening between the floor of the first level and the level of the tunnel is then worked out in two terraces, each fifty feet or so thick. The broken ore is then thrown down the shaft and charged in the tunnel into side-tipping trains of a capacity of 2½ to 3½ tons of ore, which are hauled out of the tunnel in trains by electric motors, either stationary or movable, and then transferred to self-acting inclines, which land them at the railway loading station; the inclines are shown by the double lines in Fig. 5. It is noteworthy that the ore is picked and graded in the mines, any waste or gangue being stacked in heaps to be ready for stowing in future underground workings. The shaft is divided into compartments to accommodate the various grades of ore, which are also charged into different trains. The grading is in accordance with the percentage of phosphorus in the ore.

Grade A	Below 0.05	per cent.
" B	From 0.05 to 0.1	"
" C	From 0.1 to to 0.8	"
" D	From 0.8 to 1.5	"
" E	Above 1.5	"

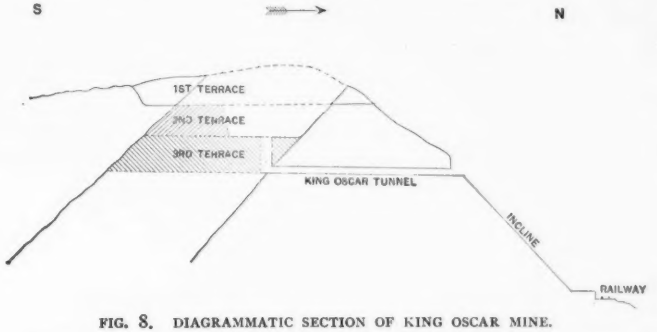


FIG. 8. DIAGRAMMATIC SECTION OF KING OSCAR MINE.

Fig. 8 is a diagrammatic sketch section of King Oscar mine, and illustrates the different stages of mining just alluded to. The space between the long inclined lines dipping towards the south represents the ore body; the space marked first terrace shows the first stage of operations; the second terrace, the second stage. It is in the bottom of this terrace that the view shown in Fig. 6 is taken. In it may be followed the mode of procedure pursued in bringing down the ore;

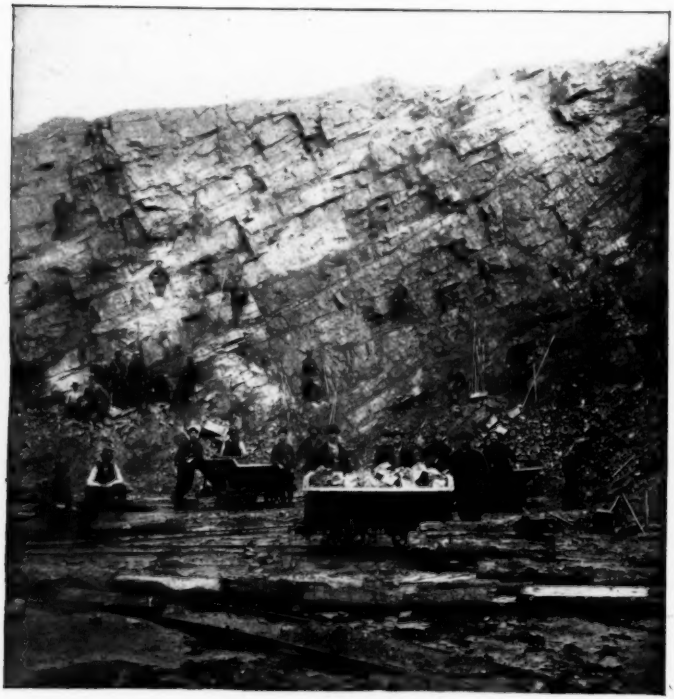


FIG. 9. IN THE SOFIA MINE.

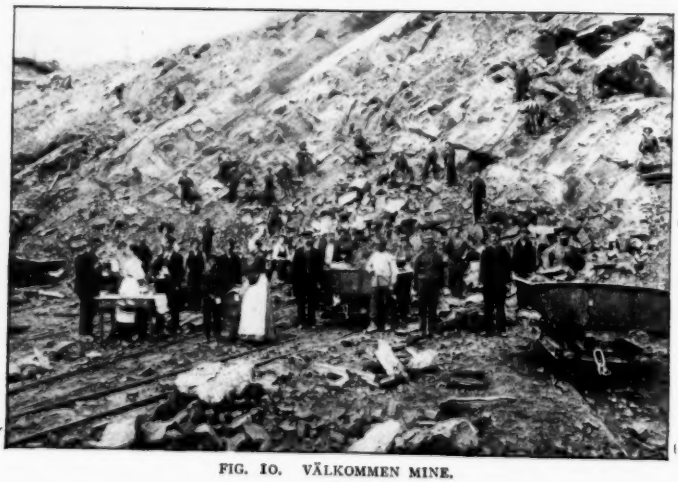


FIG. 10. VÄLKOMMEN MINE.

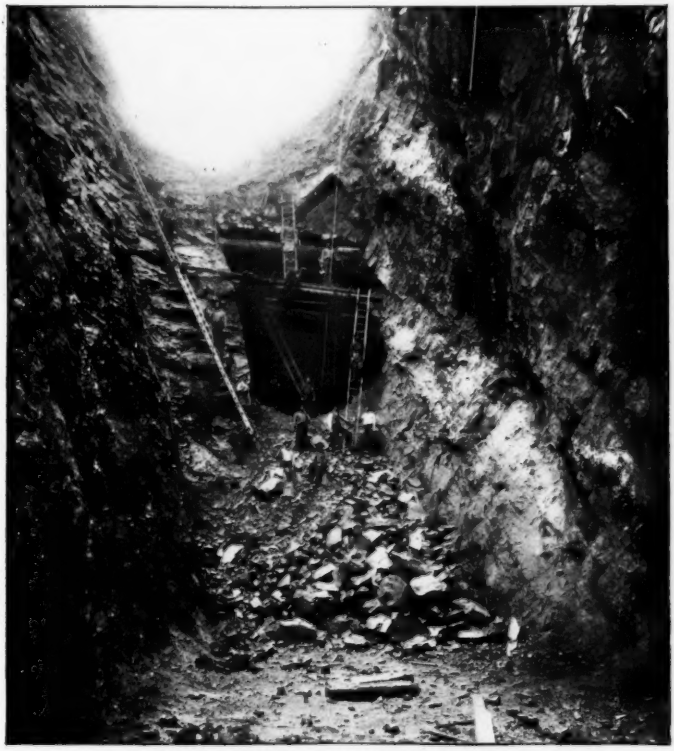


FIG. 11. WORKINGS IN THE KAPTEN MINE.

stages erected at suitable positions are rendered accessible by ladders from above or below, and upon these the drillers work. The drilling is done by hand, either single-handed with a 5- or 6-pound hammer, or double-handed with 16-pound hammers, both of which may be seen in the hands of various miners in the view. Two men work together, and bore 8 to 10½ feet of 1½-inch holes, in this hard ore, in a shift of ten hours. The holes vary in depth, according to circumstances; dynamite is used for blasting; and blocks of ore that fall are shattered by means of dynamite in a chambered hole. Loading is carried on continuously, night and day, by men working in three shifts of eight hours each—electric light being employed when artificial light is required.

Reverting to Fig. 8, the trains of ore are hauled out of King

FIG. 12. ELECTRIC LOCOMOTIVE, HERMALIN MINE AND TUNNEL.

FIG. 13. WORKING FACE, SELET MINE.

Oscar tunnel by a stationary electric motor of 18 h. p. made by Siemens & Halske, and are dispatched down the incline in trains of three to Tingvalls Kulle loading station. It may here be noted that for future working of King Oscar mine a tunnel is to be driven in at this lower level. The present tunnel is 15 feet wide by 10 feet high. The next mine to King Oscar mine is called Sofia, and is the only other one on the north side of Malmberget. Fig. 9 is a view taken in this mine, and gives a good picture of the massive jointed wall of ore seen in this working. The Sofia deposit is 1,500 feet long and from 150 to 200 feet wide; it is situated across the ridge, Kungsryggen, and is worked in two mines, the upper fifty feet above the lower, from which two inclines take the ore to Tingvalls Kulle loading station eight hundred yards away. A new tunnel, a hundred feet below the lower mine, is being driven for future working. In Sofia mine was the only vein of pyrites seen by us throughout Malmberget, and that vein was small. It yields grades C, D, and E.

The next mine is Upland. It is worked in two terraces, and yields D and E ore, which, as indicated in Fig. 5, is run down inclines to a loading station at the main railway station. The same incline receives a branch from Josefina, the next mine, which is remarkable for its great length (1,000 feet), its comparative narrowness (65 feet), and its sinuous character. The next mine is the Hermalin, which is of particular interest on account of its position at about the middle of the chain of deposits. It has been selected as the site of a main tunnel 1,433 feet long, 18½ feet wide, and 10 feet high, which is adapted for three lines of rails. It is situated so that the trains from the mine are taken round a fine trestle work gauntree as shown in Fig. 5, to a sorting and screening floor, where three classes are made,—lumps, coarse, and fine, the former two being sorted and charged as grades A, B, C, D, E, into trains which are discharged from the floors direct into railway wagons alongside, whilst the fines fall into other trains that pass beneath the structure and are ultimately also tipped into wagons. This arrangement is, and will be, of use whenever the sorting in the mine becomes impracticable. The Hermalin tunnel is to be used for working the Hermalin deposit, which was encountered when the tunnel had been driven a distance of 1,400 feet. The ore is 100 feet thick at the intersection. This tunnel is being continued in two branches, 13⅓ feet wide and 10 feet high, one to the westward to tap the Baron and ultimately the "Välkommen" deposits, the other to the eastward to reach the Skåne and ultimately the Tingvalls Kulle deposits; of course intermediate blocks of ore will be encountered in each case, and will not be neglected. The haulage in Hermalin tunnel is by electric locomotive, as shown

in Fig. 12, the load being a train of six trains, each holding 3½ tons of ore. The tunnel is lighted by electricity. The illustration in Fig. 10 is from the Välkommen mine. The overburden, in all cases, is glacial drift. It varies in thickness, and is even absent in many instances. The figure shows the mine in a later stage of development, and affords an opportunity of studying the people and the tip trains. Hæmatite as well as magnetite is met with in Välkommen as in King Oscar mine. In all three—Välkommen, Johan, and Linné—the ore is phosphatic. It is delivered down inclines to the branch railway from Malmberget stations. The first two are worked from the same tunnel, which is 830 feet long, but for future working a tunnel is to be driven in at the level of the railway. The deposits further west are of less importance.

Therefore I shall pass to the Kaptenshöjden. The deposits there, although mentioned last, are neither the least in magnitude or the least in importance. As a matter of fact, being near the station and low level, they were the first to be worked in the four mines—Hertigen, Kapten, Fredrika, and Selet. Their positions are shown in Fig. 5. Figs. 7, 11, and 13 give an idea of the workings in this part of the district. The views are, respectively, from the following mines—Hertigen, Kapten, and Selet. The ore is mostly free from phosphorus, and in some cases is, and in others will shortly be, worked out to the level of the railway; consequently the ore has to be hoisted, and three shafts are being sunk in the hanging wall. They are to be taken to a depth of 28 fathoms below the level of the railway, and in the spring underground mining operations will be commenced.

It now remains to add that the power required is supplied from an electrical station equipped with three 120-h.p. and one 360-h.p. compound condensing engines. The small engines each work two continuous current dynamos, series wound, of 250 volts and 180 amperes, while the large engine works a similar dynamo of 500 volts and 460 amperes duty. The power is utilised in 130 arc lamps, 500 incandescent lamps, 16 motors, one 30-h.p. and one 15-h.p. locomotive, and for heating the office with electric stoves. The motors are applied in the following operations: four, 2 h.p., pumping and ventilating; two, 5-h.p., crushing; seven, 18 h.p., hoisting; two, 15 h.p., in the workshops; one, 30 h.p., haulage.

The number of men employed in the mines is about 1,500 all the year round, with an additional 500 in summer, when there is a great amount of incidental and special work to be got through. Up to the present the majority of the work-people are not housed well, but the company, in course of time, will remedy that. Very little good vegetation can be grown in the district, and even the cows acquired to

supply milk during summer have to be slaughtered before winter, as they cannot withstand the severity of the season. So fresh provisions are scarce. But, in spite of the high latitude,—nearly 68°,—the temperature seldom falls below —20° Centigrade. Moreover, owing to the hills around, the place is protected from winds; and snow and frost do not interfere much with the working of these mines.

The ore wagons from all the mines gravitate ultimately to Malmberget station, where the trains are made up and despatched to Luleå. On arrival at that port control assays are made, and the ores are either stored or shipped in their particular grades. Grade E and the fine stuff are, however, heated, in order to separate the magnetite and hæmatite from the apatite. The first is separated by means of magnetic separators, while the other two are separated in an ordinary washing mill, furnished with jigs, riddles, and shaking tables. The fine iron ore is at present not a very profitable product, and many schemes have been tried to render it more suitable for melting purposes. The separated and finely-divided apatite, along with the associated quartz and felspar, is converted into a fertiliser by Wiborgh's process of drying and then grinding and mixing with salt cake, and fritting the mixture at about 1,000°. The resulting product, being finely pulverised, comes on the market as Wiborgh phosphate, and is a valuable asset. The mill treats two hundred tons of ore a day, and the yield of this phosphate is 1 to $1\frac{1}{6}$ per cent. of the weight of the ore. It is worth 75 krone a ton.

The arrangements at Luleå, or, rather, near it, are very interesting and good, for, in addition to the mill, there is a fine electrical plant, great storage places, and remarkable shipping staiths, capable of disposing of 800,000 tons in the available five months that the port is open.

One of the many delightful reminiscences of the visit to the far north of Europe was the charming view from the highest staging of the separating mill,—the fine natural harbour of Luleå, with a fleet of great vessels within loading or waiting for loading or sailing away, then the town of Luleå, and, beyond the peninsula upon which the town is situated, the head waters of the gulf of Bothnia stretching to the horizon. The whole forms a charming picture, illuminated by the early autumn sun.

THE COMMERCIAL ASPECTS OF ELECTRIC LIGHTING IN GREAT BRITAIN.

By Robert Hammond.

TWENTY years ago no works existed in the United Kingdom for the generation and distribution of electrical energy. They first came into operation for the purpose of supplying energy to arc lamps used for street illumination, the energy being, with few exceptions, distributed by means of overhead wires, the sectional areas of which were kept within practicable bounds by limiting the current to 10 amperes and by running forty or fifty lamps in series with an electromotive force of 2,000 to 2,500 volts. When incandescent lamps were invented, the lower voltages required to feed them necessitated distributors of vastly-increased proportions, and it became obvious that no extensive scheme of distribution of electrical energy could be carried out, except by means of mains laid underground.

In various parts of the country contractors and promoters entered into negotiations with vestries, municipalities, commissioners, etc., hereinafter—as the lawyers say—called local authorities, in order to secure the right or franchise of using the roads and sidewalks of the respective cities and towns for the purpose of laying such mains. Two towns—Hastings and Eastbourne—ceded such rights, the writer in both cases being the fortunate licensee. Others were prepared to follow suit, but one of the shrewdest town clerks in the kingdom, Mr. Samuel, now Sir Samuel, Johnson, expressed the opinion that, as the actual ownership of the roads was not vested in the local authorities, their rights of user of the same were strictly confined by the various acts of parliament relating to the same. They could break up the roads for the purpose of doing work on the sewers or of providing a system of street illumination, or, if they were the gas authority, of inspecting, repairing, or laying gas mains; and they could also operate at their sweet will in the direction of repairs to the road itself, or re-metalling. Beyond these powers they had none, and consequently could pass none to others. Any agreements made by them, therefore, permitting the licensees to lay down mains for the purpose of distributing electric energy were *ultra vires*, and could be blocked by any citizen who chose to take action. Sir Samuel's opinion was almost unanimously accepted as sound, and in the session of 1882 a batch of bills were promoted, the object of which was to endow local authorities with the power to

enter into agreements in respect of the laying of underground mains and the supply of electrical energy to private persons within their area. The government then drafted a bill, and it, with the eight promoted privately, was referred to a select committee, the result being the passage by parliament of a general act entitled: "Electric Lighting Act 1882 [45 & 46 Vict. CH 56]. An Act to Facilitate and Regulate the Supply of Electricity for lighting and Other Purposes in Great Britain and Ireland [18th August, 1882]."

During the investigations of the committee a large amount of evidence was tendered on the importance of preventing the supply of electrical energy from becoming so onerous for the community as the gas monopoly had become. It was pointed out that in very many cases the local authorities had been compelled to purchase gas undertakings at figures far in excess of the capitals expended thereon and arrived at by giving the gas companies the benefits of long periods of prospective profits. The committee was determined that, if the new industry became a profitable one, the profits should, as far as possible, be enjoyed by the community at large, instead of being distributed among the capitalist class. The Right Honorable Joseph Chamberlain, then president of the board of trade, had demonstrated in his adopted town of Birmingham how excellently the administration of the water and gas service could be conducted by the municipality. He supported the committee in its determination to afford every opportunity to the local authorities to lay down electricity works.

Accordingly the act empowered local authorities to expend their funds in carrying out electric-lighting undertakings, and, in cases where the local authorities desired to delay embarking in the business, and powers were granted to companies, the option of purchase of the undertaking was secured to the local authority on terms very stringent to the companies. Under the act of 1882 the options of purchase were exercisable after the expiration of twenty-one years, and of every subsequent seven years, these periods being afterwards extended, by the act of 1888, to forty-two years and ten years respectively.

In order, however, to provide that the local authority should work the undertaking for the benefit of the community at large, it was enacted that:

"All moneys from time to time received by the undertakers in respect of the undertaking, except (*a*) borrowed money, (*b*) money arising from the disposal of lands acquired for the purposes of this order, and (*c*) money not of the nature of rent received by them in respect of any transfer under the provisions of this order, shall be applied by them as follows:

(1.) In payment of the working and establishment expenses and cost of maintenance of the undertaking . . . .

(2.) In payment of the interest or dividend on any mortgages, stock, or other securities granted and issued by the undertakers . . . . .

(3.) In providing any instalments or sinking fund required to be provided . . . .

(4.) In payment of all other expenses of executing this order, not being expenses properly chargeable to capital.

(5.) In providing a reserve fund, ...

"The undertakers shall carry the net surplus remaining in any year, and the annual proceeds of the reserve fund when amounting to the prescribed limit, to the credit of the local rate as defined by the principal act, or at their option shall apply such surplus, or some part thereof, to the improvement of the district for which they are the local authority, or in reduction of the capital moneys borrowed for electricity purposes.

"Provided always that, if the surplus in any year exceed five pounds per centum per annum upon the aggregate capital expenditure on the undertaking, the undertakers shall make such a rateable reduction in the charge for the supply of energy as in their judgment will reduce the surplus to the said maximum rate of profit; but this proviso shall only apply to so much of the undertaking as shall for the time being remain in the hands of the undertakers."

For the purpose of securing the proper performance of this condition, it was further enacted that:

"The undertakers shall, on or before the 25th day of March in every year, fill up an annual statement of accounts of the undertaking, made up to the 31st day of December then next preceding; and such statement shall be in such form, and shall contain such particulars, and shall be published in such a manner, as may from time to time be prescribed in that behalf by the board of trade.

"The undertakers shall keep copies of such annual statement at their office, and sell the same to any applicant at a price not exceeding one shilling a copy."

The term "undertakers," which appears above, has been interpreted by some wag to mean those who hold the privilege of burying the cables, but is defined in the Act, Clause 2, as applying to "every local authority, company, or person . . . authorised to supply electricity (more properly, electrical energy) within any area."

Since the general community is not interested in the way in which companies deal with their profits, it may appear curious that

the provision with regard to publication of "accounts" should be made to apply to them as well as to local authorities.

On reference, however, to the "form" prescribed by the board of trade, it will be seen that the undertakers have not only to state the amount of the revenue and the working expenses of the undertakings, but to analyse the expenditure under numerous headings, which may generally be summarised as under:

(1) Coals or other fuel; (2) oil, waste, water, and stores; (3) wages on generation and distribution; (4) repairs and maintenance; (5) rents, rates, and taxes; (6) management,—*i. e.*, salaries, stationery, and printing, general establishment charges, law expenses, insurance, etc.

There is also appended a form from which, if it be faithfully and fully filled in, it is possible with ease to arrive at the cost of, as well as the average revenue arising from, the "units sold," to discover the load-factor, and to determine the percentage of "quantity not accounted for."

In the case of companies the returns have to be audited by an auditor appointed by the board of trade, and the writer can certify from experience that this audit is most searching.

This carefully-prepared and audited annual statement on the part of the companies was intended by the legislature to secure to the local authority covering the area of supply the opportunity of observing whether the profits arising from the undertaking were of sufficient importance to warrant the local authority in exercising its option of purchase at the end of the statutory period, or at any earlier period that might have been by agreement inserted in the provisional order (confirmed by act of parliament) under which the company was operating.

To give an instance of the operation of the clause:

The city of Leeds (population 402,449) owns its gas works, and supplies gas at two shillings per one thousand cubic feet, and for years the idea of the electric light being able to compete at this figure was ridiculed. In 1890 a committee of the corporation recommended that a provisional order should be applied for, in order, at all events, to prevent the inroads of a company. A strong minority of the members of the town council, however, held the view that, with the corporation gas at so low a price, there was no chance of outside capital being forthcoming to start a competition on the part of electric light, and no possibility of the commercial success of electricity supply works, if any capitalists were found imprudent enough to start them. Deciding, therefore, not to erect their own electricity works, though only by a bare majority of one in the town council, the cor-

poration was logically compelled to sanction a provisional order in favor of a company, which was at once formed by local capitalists under the conviction that there was a profitable field for electricity, however low the price of gas.

It fell to the lot of the writer, in his province of consulting engineer, to lay down the works, which were opened in May, 1893, and have shown the following highly-encouraging results:

FINANCIAL RESULTS OF ELECTRICITY WORKS IN COMPETITION WITH GAS AT 2S. PER THOUSAND FEET.

Year.	Capital invested at end of year.	Profit on Working.	Percentage on Capital employed during year.
1894	£ 64,118	£ 3,709	6.98%
1895	76,526	6,780	9.64%
1896	105,377	10,475	11.51%
1897	161,000	13,193	9.90%
Total profit for first 4 years.....		£34,157	

In this case the provisional order agreed between the company and the local authority—*i. e.*, the Leeds municipal corporation—contained a clause giving to the local authority the option of purchase

(*a*) at any time prior to July, 1901;

(*b*) by the issue to the company of such an amount of Leeds municipal corporation stock as will produce, by the interest or dividends thereon, an annuity of five per cent. upon the sum expended by the company upon its undertaking and chargeable to capital account.

The opportunity afforded to the local authority by the clause in the act with regard to the filing of audited accounts with the board of trade enabled it to judge of the advisability of securing the undertaking for the benefit of the city, with the result that the examination of the accounts convinced the local authority of such advisability; and early in 1898 it made an application for permission to purchase, to the government department,—*i. e.* the local government board, without whose consent no local authority in the United Kingdom can embark upon expenditure of capital.

The application was successful, and the local authority is proceeding to issue at par that amount of 5 per cent. stock which will cover the capital expenditure of the company to September 30, 1898.

It may be of interest to capitalists in the United States to know that Leeds 5 per cent. stock is worth about 100 per cent. premium in the money market, so that the fortunate shareholders in the Leeds company have the gratification of receiving a bonus of 100 per cent. upon their original investment.

This digression will have served to illustrate the position and status of the industry. The writer desires to emphasize the fact that the annual publication of carefully-audited accounts is obligatory on all who hold statutory obligations to supply electrical energy in the United Kingdom.

The extent to which the data have been growing may be seen by the following table:

Year.	Number of works operating or applying for powers.	Year.	Number of works operating or applying for powers.
1882	2	1891	31
1883	3	1892	39
1884	3	1893	62
1885	4	1894	81
1886	4	1895	93
1887	6	1896	112
1888	7	1897	121
1889	14	1898	132
1890	17		

The board of trade has made no publication of the returns filed with it in accordance with Section 9 of the act, and the only course open to the inquirer is to apply to the various undertakers for copies of the same.

Those who conduct industrial enterprises for profit have a strong inducement to conceal their costs of working, for, if faithfully set forth, they might provoke either competition or commiseration. Here, however, we have an industry—possibly the only one in the world—which is compelled by law to afford the minutest information as to its financial operations.

It is, unfortunately, out of my power to include the costs of production in works established solely for the supply of electrical energy to tramways, these works being under no statutory obligation to file such returns. The figures tabulated by me refer to those undertakings that are operating under the electric-lighting acts, 1882–1888, having, of course, electric lighting for their main object, and being assisted only to a very slight extent by a demand for electrical energy for other purposes than lighting; though in the provisional orders under which they are operating it is made clear that they are constituted in their districts the suppliers of electrical energy for all purposes that may be demanded.

It would take up too much space to set out the board of trade form in its entirety. I will content myself by detailing the items which make up one of the eight subdivisions:

Dr. *REVENUE ACCOUNT.* Cr.

No. III. For the Year ending 31st December, 18

A. *To generation of Electricity*	
1. To coals or other fuel, including dues, carriage, unloading, storing, and all expenses of placing the same on the works.	1. By balance from last account. Less bad debts written off.
2. To oil, waste, water, and stores.	
3. To wages at generating stations.	
4. To repairs and maintenance, as follows: Buildings, Engines, boilers, Dynamos, exciters, transformers, motors, etc., Other machinery, instruments and tools, Accumulators and accessories. Less received for old material.	2. By sale of current per meter at per B. T. U.
5. To other items (to be specified).	3. By sale under contracts.
B. *To Distribution of Electricity.*	
1. To wages and other remuneration to linesmen, fitters, laborers.	
2. To repairs, maintenance, and renewals of mains of all classes, including materials and laying the same. Less amounts refunded.	4. By public lighting.
3. To repairs, maintenance, and renewals of transformers, meters, switches, fuses, and other apparatus on consumers' premises, together with cost of materials and lamps sold, as *per contra*.	5. By rental of meters and other apparatus on consumers' premises.
4. To repairs, maintenance, and renewals of apparatus at distributing stations.	
C. *To Public Lamps.*	6. By sale and repairs of lamps, arc or incandescent. By sale and repairs of other apparatus.
1. To attending and repairs.	
2. To renewals of lamps.	
D. *To Royalties, etc.*	
To royalties, etc., payable for use of patents or patent processes.	7. By royalties, licenses, etc.
E. *To Rents, Rates, and Taxes.*	
1. To rents payable.	8. By rents receivable.
2. To rates and taxes.	
F. *To Management Expenses.*	
1. To salaries,—*viz.*, Engineers' Department, Accountant and Clerical Staff.	9. By fees for inspection of maps.
2. To salaries or commissions of collectors.	
3. To stationery and printing.	
4. To general establishment charges.	
G *To Law and Preliminary Charges.*	
1. To law expenses.	
H. *To Special Charges.*	10. By other items (to be specified).
1. To insurance, etc.	
2. To expenses for certification of meters.	
Total expenditure	
Amount carried to net revenue account.....	
Balance carried to next account to provide for bad debts.....	

In order to make a fair comparison possible between the results achieved by the various works, the writer has extracted and analysed the following costs *per unit sold* of—

I. Coals or other fuel;
II. Oil, waste, water, and stores;
III. Wages (on generation and distribution);
IV. Repairs and maintenance;
V. Total of I, II, III, IV,—*i. e.*, Works Costs;
VI. Rent, rates, and taxes;
VII. Management,—*i. e.*, salaries, stationery, and printing, general establishment charges, law expenses, insurance, etc.
VIII. Total costs.

With regard to the "unit sold," I may explain that the consumers may demand a supply as registered by meter fixed on their premises, and the "unit sold" is the arbitrary measure fixed upon as the basis of the selling price by the board of trade, the unit equalling a kilowatt-hour,

The maximum price imposed by the board of trade in the majority of the provisional orders is 8d. per unit, but the price actually charged varies in various places, the lowest prices charged at the present time being: For private lighting, 3d. (6 cents) per unit; for public lighting, 1¼d. (2½ cents) per unit; for power to factories, 1½d. (3 cents) per unit; for tramway traction, 1d. (2 cents) per unit.

In some places under the operation of the demand indicator system, the long-hour consumers get their electrical energy for considerably below 4d. per unit, the average for all services in Brighton, for instance, in 1897, being 3.77d. and in Edinburgh, 3.5d. per unit.

Obviously, in the scope of a magazine article it is necessary to limit the review of costs to those of a limited number of works, and a selection is made of those of

GROUP I.

Works situated in London.	*Pressure.*	*Outside London.*	
Kensington	Low	Edinburgh	Low & High
Saint James	Low	Leeds	High
Westminster	Low	Manchester	Low

GROUP II.

All outside London:

Bradford	Low Pressure.
Brighton	Low & High Pressure.
Bristol	High Pressure.
Glasgow	Low Pressure.
Portsmouth	High Pressure.

The division of the groups is purely arbitrary, and made for convenience.

I set out in the table the costs of working at these places, as shown by the latest returns.

TABLE OF SOME COMPARATIVE LOW COSTS PER UNIT SOLD.

	Bradford 1897 Units sold 993,588	Brighton 1897 Units sold 1,992,527	Bristol 1897-8 Units sold 910,888	Edinburgh 1897-8 Units sold 2,894,437	Glasgow 1897-8 Units sold 2,114,036	Leeds 1897 Units sold 833,280	Manchester 1897-8 Units sold 3,434,859	Portsmouth 1897-8 Units sold 981,273	London		
									Kensington 1897 Units sold 1,898,362	St. James 1897 Units sold 3,028,242	Westminster 1897, Units sold 4,355,781
	d	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*	*d*
Fuel	.38	.62	.88	.35	.45	.25	.45	64	.69	.51	.63
Oil, Waste, Water, and Stores	.10	.08	.07	.05	.06	.05	.16	.24	.11	.07	09
Wages	.34	.35	.49	.18	.26	.35	.24	.23	.29	.29	.34
Repairs and Maintenance	.17	.28	.16	.19	.49	.13	.26	.38	.42	.40	.23
Works Costs	.99	1.33	1.60	.77	1.26	.78	1.11	1.49	1.51	1.27	1.29
Rent, rates, and taxes	.28	.13	.27	.15	.30	.08	.17	.10	.41	.21	.22
Management Exps...	.52	.30	.46	.28	.36	.64	.34	.29	.69	.71	.68
Total Costs	1.79	1.76	2.33	1.20	1.92	1.50	1.62	1.88	2 61	2.19	2.19

From the above it will be seen that we have succeeded in the United Kingdom, in some dozen works, in bringing down the total costs of generation and distribution of electrical energy to less than two pence per unit.

EDITORIAL COMMENT

THE Nicaragua Canal is being actively agitated in congress, and indications point, all too strongly, toward the assumption by the government of the Maritime Canal Company's "pig in a poke"—the transfer of very definite cash for very dubious rights to carry on a work of wholly uncertain expense and difficulty. There is a suspicious fever to rush the matter, under cover of the excitement springing from the war, without waiting for the report of the commission organized and sent out expressly to obtain definite information as to the engineering aspects of the work.

Granting everything that can be claimed by the advocates of an isthmian canal, one waterway is ample—and that seems assured by the Panama enterprise. Its engineering features are apparently much more favorable, and at least are thoroughly known. It seems certain to be pushed through to completion and opened impartially to the commerce of the world without any care or expense to us. Why should we spend millions buying the trouble of an undertaking which is indefinite in difficulty, doubtful in value, absolutely undesirable as a national possession, and inexcusable as a duplicate of any corresponding waterway?

England, who, as the great commerce carrier of the world, has most to gain from any betterment of carrying routes, displays her larger wisdom by her apparent disposition to ignore the Clayton-Bulwer treaty, and to allow us to build the canal alone, if we will. The gain to commerce, and to the total wealth of the world, by the building of the canal will doubtless be enormous. It is questionable whether the actual builders will receive proportionate returns. England is quite willing to let her neighbor build the highway, assured that she may travel in it freely. She is content with the substance; we seem anxious to waste our substance on the sentiment.

THE most striking feature in industrial circles is the cumulative evidence of a great and accelerating export movement. General statistical figures are impressive enough, but individual instances bring home even a more vivid appreciation. A machine-tool builder in one of the principal manufacturing cities of the central States said recently, in conversation, that 90 per cent. of his product was now going abroad. His shop had been running day and night for months. Another tool-maker in the same city was taking all orders subject to a year's delay in delivery. The same story comes from every quarter. Ship plates are going to Belfast and to the Clyde; steel rails to Africa, India, and Europe; fire-proof structural materials to Ireland; machine-tools everywhere.

The development offers enormous possibilities for advantage to American manufacturers, but seems to be hampered by two unfavorable influences. The first is a too-general inertia—an unreadiness to meet the foreign demand halfway, study its preferences, and adapt details to its requirements or customs; the second is the short-sighted policy of secretiveness dominating many of the concerns which have made some entry into foreign trade, and which seem to fear that anyone else's participation means their own loss.

The policy which will best serve every individual is one of strong personal effort and study, and of broad coöperation and participation with every other interest concerned in export business. To a campaign of this character, the opportunities are limitless.

CLOSE on the announcement of the new tobacco and pottery trusts comes a report of another consolidation of manufacturing interests,—this time closely related to the engineer. Electric elevators furnish the province for the new "combine" which is said to have been incorpo-

rated—or to be upon the point of incorporation—with a capitalization of $11,000,000.

Many strong arguments have been advanced to justify the trust. The elimination of unnecessary duplication, the removal of ruinous competition, the ability to introduce effective economies in large-scale manufacturing, the advantages gained by a comprehensive view of supply and demand—all these are arguments of weight. In one notable instance, vast profit to the promoters has proved consistent with great gain to the consumers; but the conditions were peculiar, especially in the foundation of the business upon natural supplies of limited distribution.

If the movement is in accord with natural evolution, it will thrive; otherwise it will have its day and disappear—like monopolies by royal patent, the policy of protection, and other attempts to direct industry into artificial courses.

It is hard to see how it differs from the shortsighted efforts of the labor-unions to check individuality, and to force the march of progress into the step of the chain-gang. Progress springs from the individual; the average is raised by emulation of the leader, and the leader is stimulated by the opportunity for great personal reward. For a time, the artificial order may seem to prevail. Eventually, it will find its limitations in the decadence due to mediocrity within its bounds, and the impossibility of stifling the constantly-springing individual competition without.

THE fuller examination of the fire-damaged Home Life Insurance building, in New York, is relied upon to settle many extremely interesting questions concerning the steel-skeleton construction.

At present writing it is early to dogmatize, but some facts seem clear. One is that open spaces and unprotected glass windows are not fire-resisting; this hardly needed demonstration—but yet, in spite of regulations, the building was not provided with the prescribed iron shutters. If it had been, it would, in all probability, have been practically uninjured to-day.

A second is that the prediction of Chief Bonner is completely fulfilled. When the "skyscraper" takes fire on top, even the powerful department whose apparatus and organization were illustrated in these pages last February can do nothing but "let her burn." The outcome seems to be a revival of the agitation for a building law limiting the extreme height of these structures. The effect of the demonstration upon tenants and insurers, and, through them, upon investors, should be more effective than any legislation.

On the whole, the building seems to have resisted the external fire remarkably well; but, once the fire had gained access, it burned fiercely—with an intensity sufficient to melt brass fixtures, wreck partitions, destroy the stone curtain wall, and possibly so damage the steel structure itself as to demand the demolition and rebuilding of some portion, at least, of the framing. It seems impossible to resist the conclusion that equal disaster could follow a fire originating entirely within the structure, in any story above the reach of the streams from the engines.

It is safe to predict that rebuilding of the steel framing, if necessary, will prove extremely troublesome and expensive—so much so as to startle the insurance companies who have been writing these risks at absurdly low rates.

THE world will probably see, in Porto Rico, the opening of a new territory that is old, and the most perfected resources of engineering applied to pioneering work. The seizure of the island by the United States during the recent war with Spain will result in the exploitation of one of the richest regions in the world, and it is altogether likely that it will be done in a most original and characteristic fashion.

The island is almost rectangular in shape, 95 miles long and 35 miles wide. There is the usual strip of flat coast lands extending throughout the circumference, while the interior is a mountainous plateau having elevations of about 3,800 feet above the sea level. Almost the whole area is under cultivation, sugar cane and tobacco growing luxuriantly on the lowlands, while

coffee and tobacco, as well as many fruits and vegetables, are cultivated on the central plateau. There is one road, the magnificent Spanish military road across the island from San Juan on the north to Ponce on the south coast, and in all about 35 miles of railway, in three disconnected sections. The population is about one million, and there are several large and well built towns, those in the interior being generally at elevations of from 1,000 to 2,000 feet above sea. The climate is genial and there is no yellow fever, the interior being reported as extremely salubrious. In many ways the island bears a strong resemblance to Ceylon.

While there is already much wealth in Porto Rico, two causes have contributed to hamper the development of its very great resources—the total absence of means of transportation and the almost incredible dishonesty of the Spanish régime, now happily superseded. In addition to these considerable obstacles there has long existed an organized system of brigandage, taking toll of all merchandise going into or out of the interior. The percentage demanded by these highwaymen is reported at from ten to fifty per cent.

On the few miles of railroad the charges have been most exorbitant. Between Yauco and Ponce, a distance of 18 miles, the passenger rate was one dollar and the freight rate twenty dollars per ton. Even under these conditions the island has flourished because of its surpassing fertility. Its mineral resources are absolutely undeveloped and, for the most part, unknown.

There is an abundance of water power, no less than one thousand two hundred small streams and twenty-one large rivers flowing into the sea along the coast, most of them being torrential streams descending the mountain slopes within a few miles of the coast. The flow is not intermittent, for even in the dry season these streams are full. In the rainy season many of them are raging torrents.

Almost the first proposition that has been made public for the complete exploitation of Porto Rico is the construction of electric tramways through the interior. It has not been proposed to build roads, for it is now well recognized that the most costly of ordinary means of transportation is that in vehicles drawn by animals over ordinary roads—especially in a hilly region. This project seems so eminently sensible, especially in view of the large undeveloped water powers of the island, and the fact that its whole area is so small that electrical power transmission from any part of it to any other is feasible, that it ought to be put into execution at the earliest possible moment. With immunity from the exactions of brigands, swift and inexpensive transportation from the interior to the coast, and relief from the various forms of legalized robbery that have existed, there is no reason why Porto Rico should not soon be one of the richest islands in the world.

The spectacle of electric tramways building in advance of ordinary roads is one that would have been even more startling five years ago than it is now; but even to-day it is an indication of the wonderful progress that has been made in the utilization of electricity and the readiness with which this agency lends itself to varied and useful purposes.

* * *

THE advent of the United States in the east as a colonizing power makes the construction of a trans-pacific cable an actual necessity. There has been a considerable discussion of this subject in the newspapers for a long time, and it now seems that the cable must, of necessity, be laid, but there are engineering questions of great magnitude and importance to be answered before the actual work upon it can be begun.

Assuming that the United States will undertake the construction for themselves, or that they will subsidize a company to lay a cable to the Philippines from San Francisco, the first landing place would be in the Hawaiian Islands. The next possession of the United States is the island of Guam, in the Ladrones, which is about 3,100 nautical miles west of Hawaii. From this island to the mainland of Luzon, in the Philippines is about 1,650 nautical miles.

The longest cable now operated is that from Brest to New York, which is 3080 nautical miles in length. The cost of cables increases with their length in a geometrical ratio; the difficulty of working them increases about as rapidly. Remembering that the cost of the New York-Brest cable was greater than that of any other cable ever laid, it is readily seen that the construction of the American trans-pacific cable, involving the link between Hawaii and Guam, may well be approached with caution.

Of course such a cable as this would not have the volume of business that keeps the transatlantic cables constantly at work. Tolls would of necessity be high, service slow, because of the increased difficulty of rapid working in long cables and, indeed, it is much to be doubted if the investors in the enterprise would be rewarded with a dividend even under the most favorable conditions. This view of the matter, of course, assumes that the ownership of the cable is vested in private persons. If it is constructed this will doubtless be the method, there being much opposition to government control or ownership of telegraph lines in the United States, though it is conceivable that the government might lay such a cable as a part of its necessary and expanding military equipment.

The solution of the difficulty is in the acquisition of an island of the Caroline group. If a landing can be made on one of the most easterly of these islands, the long step from Hawaii to Guam would be divided and, although no island of the Carolines is on the direct route of the cable, the loss due to the increased total length of the cable would be much more than compensated by the greater ease and certainty of working the shorter links, and the less cost of the individual lengths of the submarine construction.

In connection with the Pacific cable a very interesting question arises. From whence is the gutta-percha for this gigantic cable to come? Every whisper of the construction of a trans-pacific line sends the gutta market at Singapore up by leaps and bounds. The ruling price of the gum is the highest that has ever obtained. It is stated, on what authority it is hard to say, that the visible supply of gutta is insufficient for the task, and that if this cable is laid it will be the last—the last with a gutta-percha insulation, at least. While this pessimism on the part of the gutta producers savors somewhat of a desire to stiffen the market, there is yet a sufficiently reasonable foundation for it in the wanton destruction of the gutta forests. It will be interesting to see the outcome of the situation. If the United States acquires an island in the Carolines the building of the cable line seems possible, though expensive. If they do not find a landing place the operation of the cable seems to require a prohibitively costly plant. And meanwhile there is the question of the disappearing gutta tree.

* * *

If recent reports are to be believed, we are to have a great shipbuilding plant framed on the lines of those at Jarrow, Elswick, and Barrow-in-Furness—ready to build, arm, and equip a warship complete. Mr. Carnegie and others have recently asserted that the United States were now so favorably situated, with reference to economic conditions, and progress in the iron and steel trades especially, that we could compete most successfully in the shipbuilding industry. We are already sending ship plates abroad; with our skill in labor-saving in mechanical construction, we should certainly be able to build them into ships at home.

The Newport News yard is, by the very fact of its comparative youth, probably the best arranged and equipped plant in existence. Now we are told that Vickers, Sons and Maxim contemplate installing a gun-making plant at Newport News in connection with the acquirement of an interest in Mr. Huntington's yard. This introduces the necessary element of acquired, specialized experience. There is a lesson for us in England's quickness to take her capital and talent to the best market, wherever that may be.

THE BRITISH PRESS

Review of Leading Articles

The Coal Industry and National Progress.

IT is not uncommon for statisticians to attempt to measure the industrial condition of a nation by a study of some particular branch of trade, supposed to be of so general a character as to give a fair measure of the progress in all branches of industry.

Bank clearings, postal and telegraph business, the stock market, and many others have been used in this manner, but it is evident that these may vary from causes which do not necessarily give true indications as to legitimate business activity.

A paper in a recent issue of the *Colliery Guardian* points out the value of the indications of the coal trade as an index to general trade conditions, and draws some deductions as regards British industries. The production and use of coal lie at the bottom of so many manufacturing enterprises that the consumption of coal may be regarded as a fair indication of progress and prosperity; hence some interesting conclusions may be drawn from the study of comparative statistics.

The position of England in this respect is peculiar, since she is not only the greatest producer of coal, but also the greatest exporter; hence the coal production is a measure not only of internal industry, but also, to a certain extent, of foreign trade.

"If we could use the figures representing the output of coal as indicative of commercial and industrial supremacy, then would Great Britain's position be unquestionable. But, although every ton of coal worked, whether it is used at home or shipped to some foreign port, stands for labour employed and wages earned and revenue received, it is so much more important as a medium to creating additional value that we must look rather to consumption than to actual production."

Regarded in this light, all the coal exported by England to competing countries might be considered as so much aid and comfort furnished to the enemy,—a feature which is worthy of consideration.

Although Great Britain at present stands easily first in the matter of absolute production, America is rapidly approaching her output. Since nearly all the coal produced by the United States is consumed at home, its relation to outside trade is an indirect one, and must be considered separately.

Taking the leading coal producers of Europe, the most notable advance has been in Germany; France and Belgium having changed places, but without joint advance. Thus from 1860 to 1895 the relative productions expressed as percentages were:

	Great Britain	Germany	France	Belgium
1860.....	71.9	12.7	7.0	8.0
1895.....	59.9	24.6	8.6	6.3

"The position of Great Britain, therefore, as a producer of the source of steam power has, in relation to the other countries named, altered from 71.9 to 59.9 per cent., while Germany has contributed to the necessary power of the four nations 11.9 per cent. more than she did thirty five years ago."

The actual quantity of coal consumed in each country is naturally more difficult of determination, but the available figures show that, while the consumption in Great Britain about doubled from 1860 to 1895, that in Germany trebled, and that in 1860 Great Britain used five times as much coal as Germany, and in 1895 only about twice as much. So far as consumption is concerned, Great Britain is, in the aggregate, far ahead of Germany, but the increase in coal consumption in the latter country indicates in a general way the manner in which she is threatening British industry in various directions.

Adding now the factor of the United States, we get an idea of the increasing importance of that country in the manufacturing world, and the potential force it will exert in the future. Going back only

to 1870 and considering only Great Britain, Germany, and the United States, we have for the relative percentages of production:

	Great Britain	Germany	United States
1870	66.5	15.6	17.7
1895	43.7	17.9	36.0

Besides, in the matter of coal consumption the United States is already ahead of all countries, so little coal being exported that practically the whole of the raisings is consumed in the country itself for manufacturing and other purposes. In 1895 the total consumption, expressed in thousands of long tons, was:

Great Britain	159,045
Germany	72,094
United States	166,684

The remarkable position thus indicated for the United States shows that country to be already at the head of the nations as a manufacturing people, though as an exporting country Great Britain still maintains its supremacy, measured by its potential capacity in coal.

Rotary Converters.

THERE are a number of unexpected and somewhat puzzling actions which take place in a rotary converter, the explanation of which has hitherto been confined to a few publications of a mathematical nature. Indeed, the theory of the converter may be said to have lain buried in a mass of formulæ not over-easy of comprehension, until Professor Silvanus P. Thompson read a paper on the subject at the last meeting of the Institution of Electrical Engineers. This presents, for the first time, to readers of English, a consistent and simple theory of the operation of rotary converters—called by the author "rotatory converters"—and a summary of the entire literature of the subject. The clear and even elementary nature of Professor Thompson's explanation renders his paper one of especial value.

After a general statement of the theory of the machine, the author remarks at length upon the anomalies of heating in the armatures of rotaries operating on single-phase and polyphase circuits. A number of diagrams are given, showing the instantaneous values of current in the armature coils under different circumstances of commutation and phase relation; and the rather interesting question of alteration in the voltage ratios of the two sides of the machine by changing the shape of the alternating-current wave—or, in other words, by altering the width of the polar embrace—is discussed at some length. The paper closes with a description of a number of designs of rotary converters, including the ingenious and remarkable machine of MM. Hutin and Leblanc, which is better known by its barbarous French name of *panchahuteur* than by the equally strange title of "permutating machine" given it by the author.

Excellent and valuable as Professor Thompson's paper is, it is marked by a few omissions of really essential facts of the theory of the rotary converter. There is practically no discussion of the enormous increase of heating in these machines due to displacement of phase between the current and electromotive force on the alternating side, or any consideration of one of their most valuable features in practical work—their ability to act, like synchronous motors, as phase replacers. A rotary working on an alternating system is, to all intents and purposes, a synchronous motor, and proper manipulation of its field excitation causes the machine to impress either a leading or lagging phase on the line current. Consequently a rotary can be used to rectify any displacement of phase on the line, due either to the capacity or induction of the system, by introducing a compensating displacement of the opposite sign. A singularly beautiful case of the regulation of voltage on a large American power-transmission system in this way has recently been described at some length by Mr. C. P. Steinmetz.

Professor Thompson's paper will be of real use to students of the subject, because it presents the theory of the rotary without mathematics and in as simple and intelligible a way as seems possible when the somewhat intricate character of the subject is considered.

The Influence of Exhibitions.

IN the inaugural address of Mr. George Russell before the Institution of Engineers and Shipbuilders in Scotland a number of interesting points are brought out, and among these is the view which he takes of the advantages and disadvantages of international exhibitions, so far as the exhibitors are concerned.

After briefly reviewing the progress of such exhibitions from 1851 to the present time, Mr. Russell proceeds to discuss the influence which has been exerted by them.

"The tendency of international exhibitions has been to spread knowledge—which was formerly local or national—over the whole world. Fifty years ago Great Britain was far in advance of other countries in engineering, shipbuilding, and general manufactures. The exhibition of machinery in motion, showing processes of manufacture, enabled the foreign visitors to copy and emulate them in their own countries, and then establish competing centres for supplying the markets of the world.

"The effect commercially on Great Britain of such exhibitions has thus not been beneficial, but the reverse. Knowledge, however, cannot be confined to any one country or locality in perpetuity. It is bound to spread ultimately over the whole world. But these exhibitions have greatly accelerated the process, and shortened by many years the period of Great Britain's lead in engineering matters. By exhibiting all we knew, foreigners were able to get the benefit of our experience, and save the long and tedious time of evolution.

"Fifty years ago the advantages of these exhibitions were very unequally divided, but at present they are more nearly balanced.

"The most advanced practice in engineering and shipbuilding is no longer confined to Great Britain, for machinery of every class as complete, efficient and powerful, and steam vessels as large and speedy, are produced in America and on the continent. Indeed it is very noteworthy that the three largest steamers of last year were built in Germany, and that at present that country has the honor of of holding the 'blue ribbon' for speed in Atlantic voyages."

While there is much truth in the fact that international exhibitions have done much to disseminate knowledge and promote competition, it is not so certain that this has been an injury, even to the nation which has had the most to give. The stimulus of international competition must react upon the giver and prevent the tendency to decay and the disposition to rest upon past earned laurels, and there is no surer inducement to nations and individuals to push forward in the struggle than such displays as have been given at past exhibitions, and may be expected in the coming one.

It is quite possible to imagine that if there had been no international exhibitions during the past fifty years, England might have a greater lead in industry and commerce over other nations than she now has, but it is a matter for question whether her absolute advance would have been so great as it is in fact. The spur of competition may have been sharp, but it has been the cause of progress which would not otherwise have been obtained.

It is a matter of common note that the most advanced and successful establishments are also those which are most liberal in the disclosure of methods and products, and that manufacturers whose works are surrounded with secrecy are usually in possession of little or nothing which is worth acquiring. Be this as it may, it is quite certain that exhibitions will continue to be held, and that all progressive nations will participate, and the progress of the world will thereby undoubtedly be advanced.

Polyphase Traction.

THE question of the use of polyphase motors for traction is one of perennial interest, and a matter of such importance that it is to be regretted that so little experimental data concerning it have been accumulated. So far, there are but two or three railways, mostly short and unimportant lines, using the polyphase motor on their cars, and these, being of special type,

have not afforded an opportunity for the development of a proper control system for the induction motor.

The *Electrician* sums up the whole case of direct current *vs.* polyphase traction in a recent editorial, and concludes that, "on the whole, both from the point of view of inductive and earth-current disturbance and of economical and practical working, the advantage, at any rate at present, lies with the continuous-current motor." The argument upon which this conclusion is based is that the various external disturbances due to an electric railway are inherently more difficult to eliminate when it is operated by alternating currents, and that the difficulty of regulating the speed and torque of a polyphase motor are very great. While it is likely that the justice of this position will be admitted, even by the most ardent advocates of the polyphase system, there are certain intrinsic advantages possessed by the alternating-current distribution systems—notably the possibility of eliminating sub-stations for an extended distribution, the simplicity and mechanical strength of the generating apparatus, and the possibility of long-distance working from a single station—which point to most elegant solutions of many difficult electric traction problems.

There is now ample evidence that a two-conductor system will work admirably in a conduit. A three-conductor system—requisite for polyphase transmission—would almost certainly work as well. If any system of control can be devised whereby the torque and speed of an induction motor may be varied and regulated with an ease and certainty approaching that of an ordinary direct-current motor, the vast superiority of the alternating-current conducting system will result in the installation of many railways equipped with polyphase apparatus throughout, instead of with the less efficient combination of polyphase generator, transformers, and direct-current motors.

Meanwhile, however, the practical advantages appear to lie with the direct-current system, but the problem of designing a proper polyphase traction equipment does not seem insoluble.

The Formidable and the New Maine.

THERE was launched recently, at Portsmouth, the largest battleship yet constructed, H. M. S. Formidable. This magnificent vessel, which is fully described in the *Engineer*, possesses many points of novelty in design and equipment, which, when considered with her great size and powerful armament, make her of peculiar interest.

Of the external features of the design perhaps the most striking is the cutting away of the deadwood aft and the keel forward for considerable distances. It is believed that this will greatly facilitate the turning of the ship, and assist evolutionary movements to a marked degree. The stern-post is a solid steel casting, descending for eleven feet below the recessed stern and forked out forward and aft beneath the tiller compartment to assist in stiffening the stern framing. The ram bow is a single casting, running from the stern to the ram proper, which is shaped like a gigantic thimble. Sloping up to the ram for a distance of forty-five feet are the vertical and flat keels, which are securely bolted into it. Into the ram is also inserted a horizontal forty-pound stiffening plate, running back to the seventh frame bulkhead, the eighth being the collision bulkhead proper. The ram may thus be driven in a considerable distance, without injury to this important bulkhead.

It is interesting to note the comparison between the details of this ship and its armament, and those of the three new battle-ships, now under construction for the United States navy, published in a recent paper by Chief Constructor Philip Hichborn. The Formidable is 430 feet long over all, 75 feet extreme beam, and 26 feet 9 inches draught at normal displacement of 15,000 tons. The Maine, which is a type of the new United States ships, will be about 394 feet over all, 72 feet feet beam, and 23 feet 10 inches draught at 12,500 tons displacement. The Formidable is provided with 15,000 h. p., 1 h. p. per ton displacement, while the Maine will have 16,000 h. p., or 1.28 h. p. per ton displacement. The speed ex-

pected from each vessel is the same,—eighteen knots,—but the Maine seems to have somewhat the better chance of attaining, or even surpassing, this velocity. The Formidable has bunker capacity for 2,100 tons of coal, the Maine for 2,000 tons.

Both vessels are to have water-tube boilers. The Formidable will be provided with twenty independent Belleville boilers, supplying steam at 300 pounds, which will be reduced to 250 pounds at the engines. The Maine will be equipped with Niclausse boilers, twenty-four in number, working at 250 pounds' pressure.

Turning now to armour, the British ship has 9-inch side armour, 15 feet deep and extending fore and aft 216 feet. By diagonal armoured bulkheads the total length of the citadel is made 250 feet. The slopes of the armoured deck are three inches thick, all the armour being Harveyised steel. Forward of the citadel the sides are protected with a 2-inch Harveyised steel belt, while there is a flat 2-inch armoured deck forward and a similar flat 3-inch armoured deck aft. The gun hoods for the main battery are 8 inches thick, and the armoured redoubts or batteries, containing also the hydraulic mechanism, are 12 inches thick. The sponsons in which the secondary battery is mounted are 6 inches thick.

The Maine will have 12-inch side armour 4 feet 6 inches high, from one foot below the mean load water-line, and 8½-inch armour below this for 3 feet. Above this main belt her side armour is 5½ inches thick. The superstructure armour is to be 6 inches thick, the turrets for the main battery 15 to 17 inches, the barbette armour 10 to 15 inches, the protective deck armour 2¾ to 4 inches, and the conning tower 10 inches.

In gun power there is a similar disproportion between the ships. The Formidable is to mount four 12-inch wire-wound guns, twelve 6-inch quick-fire guns (of which eight will be on the main deck and four in corner casemates on the upper deck), sixteen 12-pounder quick-fire guns, and two 12-pounder field guns. In her tops she will carry six 3-pounder Hotchkiss guns, and eight small Maxim guns will be mounted on the superstructure. The vessel is also provided with four submerged 18-inch torpedo tubes.

The Maine will carry four 13-inch guns, fourteen 6-inch quick-firing guns, 20 6-pounders, six 1-pounders, 4 Gatlings, and 1 field gun.

This brief comparison shows that, while the Formidable is the larger ship, the Maine is superior in weight of armour and power of armament and far superior in horse-power of machinery in proportion to displacement. The British ship has the better secondary battery, her sixteen 12-pounders outclassing the twenty 6-pounders of the United States ship; but it is doubtful if, in case of a torpedo attack, the greater number and handiness of the Maine's 6-pounders would not more than compensate for their smaller calibre. In main battery the Formidable is distinctly inferior, not alone in the smaller size of her great guns, but in carrying two less 6-inch guns than the American ship.

In coal capacity, and hence in steaming radius, the two ships are more nearly alike, but the greater bulk of the Formidable more than compensates for the superiority of 100 tons in her coal-carrying ability. The two types probably represent the highest achievement in battle-ship design, and their trials will be awaited with no little interest on both sides of the Atlantic.

High-Pressure Steam as a Mining Explosive.

THE frequent occurrence of coal-mine explosions has led to a very considerable amount of research upon the nature of fire-damp, and to no little invention of new blasting explosives and processes. Among these none more remarkable has been suggested than that presented by Major General H. Schaw at the recent Birmingham meeting of the Institution of Mining Engineers. In brief, his process of blasting is by the use of a steel cartridge partly full of water, which is heated, by means of a platinum wire and the electric current, until the expanding steam bursts the shell and brings down more or less coal. It is

proposed to so regulate the strength of the cartridge case that it will burst at about 150 pounds pressure per square inch. Such a contrivance, 1¾ inches in diameter and 3½ inches long, could be brought up to this pressure in about ninety seconds with a current of 160 ampères at 60 volts —or about 25 h. p. The platinum wire is 6.1 inches long and 0.013 inches in diameter, and is immediately vapourised in a atmosphere of steam when the explosion of the cartridge removes the cooling water from contact with it. Such a cartridge will exert a force of about 1½ tons. It is needless to say that it will be safe to handle and apply; but it is greatly to be doubted if it will be safe to explode such a cartridge in a fiery mine.

If a conductor having a difference of potential of 60 volts at its ends is immersed in water, the effect will not cease at the heating of the wire and boiling of the water, but will include a copious decomposition of the water with freeing of oxygen and hydrogen in their most explosive proportions. Indeed, it is extremely likely that this effect would be the more marked of the two. In such a case, if the water-level lowered, so that the platinum became exposed to the mingled gases and steam, its affinity for hydrogen, even if there were no electric current to assist, would immediately bring it to a red heat, and determine an explosion of a very violent and flaming character—precisely the kind the inventor seeks to avoid.

The Mond Nickel Extraction Process.

THE existence of a volatile compound of nickel and carbon monoxide—discovered about ten years ago by Dr. Ludwig Mond—is not simply a curiosity of chemistry; the compound appears to be destined to play an important part in the nickel extraction industry.

Nickel carbonyl is described at length in a paper by Professor Roberts-Austen lately read before the Institution of Civil Engineers. It is a liquid, readily distilled without decomposition, but which, when heated to 150 degrees centigrade, decomposes with deposition of nickel, the carbon monoxide going off as gas.

So promising was this discovery, it being found that the nickel carbonyl was readily obtained by the direct action of carbon monoxide on nickel matte, that after a number of experiments on a laboratory scale a small works was erected at Smethwick, near Birmingham.

The process begins with bessemerised matte, which is first dead roasted, after which it contains about 35 per cent. nickel, 42 per cent. copper, and about 2 per cent. of iron. The second part of the process consists in the extraction of about two-fifths of the copper by sulphuric acid, the copper sulphate obtained being crystallised and sold in that form. From this process the residue contains about 51 per cent. of nickel. Reduction of the nickel is then accomplished in a shelved tower, the reducing agent being the hydrogen contained in water-gas. The temperature at this stage should not exceed 300 degrees.

From this tower the ore is continuously carried over to another tower in which the process of carbonyl formation and volatilisation is carried on, a stream of carbon monoxide at a temperature not exceeding 100 degrees centigrade flowing over the ore. The carbonyl vapour passes to still another tower, or a retort, and is there heated to a temperature of 180 degrees centigrade, when the nickel is deposited, either on thin sheets of iron or on nickel granules. The carbon monoxide released from the nickel carbonyl is returned to the volatiliser to be used again.

The partly extracted ore from the volatiliser is returned to the reducer and thus passes back and forth for a period of from seven to fifteen days, or until about 60 per cent. of the nickel present is removed as nickel carbonyl. The residue from this operation amounts to about one-third the original calcined matte and differs little from it in composition. It is removed and added to the matte in the first operation, and thus returns through the cycle of operations until all the nickel is extracted.

The product contains 99.8 per cent. of nickel. About 80 tons have been produced, and the process is said to be able to compete with any other for the production of metallic nickel.

American Expansion and Trade.

A RECENT editorial in *Engineering* deals with the questions which have arisen because of the inevitable expansion of American influence in matters commercial as a consequence of the Spanish war, and some of the views expressed are well worthy of careful consideration.

"The great industrial development which has taken place in the United States in recent years has made an extension of foreign markets a necessity. American competition is being keenly felt in certain departments in some of the countries of Europe and in the Far East, and before long it is certain to be felt still more.

"With the enormous and enormously-increasing productivity of the American Union, trade will become more and more an absolute necessity of industrial existence. It will naturally be found towards what we call the Far East, in Australia, and throughout the wide Pacific area. Before that valve can be made fully effective the engineer must be called in to make the necessary connections. The Nicaraguan canal must be completed, not only for the purpose of giving a shorter route from the manufacturing eastern States to China, Japan, and the Far East, but also for the whole of the South American coast. We need not meantime discuss all the possibilities raised in connection with that undertaking; it is admitted by all who have studied the subject that they are great, and it is certain to give a great impetus to the development of the Pacific, both commercially and politically.

"On the other hand, we have the Trans-Siberian railway, connecting the Far East with Europe, and it is certain soon to be connected with the main lines in China, which will open up immense fields for trade and industry. Hawaii and the Philippines will not only be important possessions in themselves, but will also be stepping stones in the Far East, as well as important naval stations, which will enable the United States to dominate the Pacific. A recent writer has estimated that nearly three-quarters of the whole population of the globe is to be found on and bordering on the Pacific area. What a prospect this opens up for an energetic and ambitious people, not only for industrial and commercial development but also for political and civilising influence! If the United States were joining hands with Great Britain, their power would be irresistible, and it is certain it would only be used for the advancement of progress and civilisation, with a due regard to the interests and feelings of all other nations of the world."

Etheric Telegraphy.

IN a late issue of *The Engineer*, Mr. W. H. Preece gives a very interesting account of some of the earliest experiments in telegraphing between distant points without the use of a communicating wire, citing especially the facts that a message was sent by him without wires over a space of 3.3 miles in November, 1892, and that he received a message from Lord Kelvin which had been sent through space between Alum Bay and Bournemouth in July of 1898. "In each of these cases wires were used at the terminal points to control, direct, and transform the energy used, but the medium for the transmission of the disturbances that were translated into words was the ether," For this reason Mr. Preece objects to the term "wireless telegraphy" and also finds the German name "spark telegraphy" undesirable, preferring the expression "etheric" telegraphy. It will be recalled that Professor Silvanus Thompson has already suggested the term "space telegraphy," and either this or the name given above by Mr. Preece may be used to advantage.

The fact that electric currents may be transmitted without wires has long been known, and the existence of stray currents in the earth, and of the inductive action of electric waves, has been the prime reason for the use of metallic return circuits for telephones. Attempts have been made during the past ten years to utilise the telephone as a transmitter and receiver over varying distances and with some measure of success.

"All the earlier experiments were made with coils of wire and with metallic circuits embracing wide areas, but it was

soon found that single wires dipping in the earth at each end were equally effective and at short distances gave better results. Across Loch Ness, a distance of one mile and a quarter, it has been found possible to speak by telephone. Earth conduction came in as a friend to assist the result, but it is very easy to show that the prime effect is etheric. A gutta-percha wire floating on the surface of the sea three miles away, with its ends making earth in the sea, is affected and emits sounds; but if it sinks below the surface all sounds cease, and the telephone is no longer affected."

These earlier methods, however, have been superseded by the use of electric waves or impulses of high frequency, and it is mainly of Marconi's practical experiments in the use of electric waves for the transmission of intelligence that Mr. Preece writes.

"These waves permeate space just as light waves do, and the distance to which they extend is apparently unlimited, but the distance at which they are recorded depends simply on the delicacy of the apparatus—the electric eye—used to detect their presence.

The waves are excited by an ordinary induction coil, and received by a very delicate detector discovered by Branly, called by Lodge a "coherer," and converted by Marconi into a telegraph relay.

This relay consists of a glass tube about 1 inch long and ⅛ inch in diameter, into the ends of which are fitted two silver pole-pieces separated from each other by a space of about 1-50 of an inch, this space being lightly filled up with a mixture of fine nickel and silver filings. The tube is then exhausted to a high vacuum and sealed. In this normal condition the metallic powder is an insulator and allows no current to pass through it. But let an electric impulse fall upon it, and its condition changes, order is impressed upon its discordant ranks, it becomes a conductor, it coheres and allows a current to pass. This will continue until it is tapped, or mechanically shaken, when it instantly returns to its previously insulating state, and is in fact decohered,

Marconi decoheres by making the current itself vibrate a small hammer against the glass tube, which in striking emits a sound. Such sounds can be formed rhythmically into a telegraphic language or the current so set up can actuate a Morse or Kelvin recorder, and print the messages in dot-and-dash letters.

The extent to which such apparatus can be utilised in practice remains to be demonstrated, the most successful trials having been made at sea, where communication has been held over a distance of fifteen miles.

Mr. Preece is of opinion that the field for the use of etheric telegraphy is limited "except if it be made practical between ship and ship and between ship and shore. This is the region where the system would be not only useful but beneficial."

THE CONTINENTAL PRESS

Review of Leading Articles

Metric Screw-Thread Systems.

ALTHOUGH the metric system has now been in use in nearly every industrial country on the continent for many years, there is yet no standard system for metric screw threads, and there is no assurance whatever that any metric nut will fit any bolt of the same diameter, as either the pitch or the shape of thread, or both, may be on different systems from that of the nut. This is not because there has been no attention given to the subject of metric screw-thread systems; on the contrary, many such systems have been proposed; the trouble appears to be that of too many systems rather than too few.

It is doubtless for this reason that in very many of the large establishments on the continent the Whitworth screw-thread system is used, not only as regards pitch and form of thread, but also for diameter of bolts; so that, while all other dimensions of a machine may be in metric units, the bolts and nuts will be found to be in English sizes, and conforming to the Whitworth standard. The inconvenience of this use of two systems of measurement is undoubtedly offset by the fact that standard gauges, taps, dies, and nuts can be procured without difficulty, and with the assurance that they will interchange wherever found.

The attempt to secure a standard metric screw-thread system, however, has not been abandoned, and the latest effort in that direction is that put forth by the congress for the unification of screw-threads which has recently closed its sessions at Zurich.

From the report made public in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, and from the discussion of the German Railway Society published in *Glaser's Annalen*, the especial features of this latest metric candidate for public favor are obtained.

Switzerland is eminently adapted for the discussion of any international matter, since the jealousies which might arise elsewhere can be better controlled, and the prospects of united action thereby advanced.

The real difficulty with the metric screw-thread systems is the unsuitability of the millimetre as a unit of progression, if the decimal system is to be preserved. In the English system of Whitworth, and the American system of Sellers, the continual bisection of the inch makes the sixteenth of an inch a convenient rate of progression for bolt-diameters without departing from the general practice of shop measurements, while the pitch is expressed in an integral number of threads per inch in nearly all cases, in a form which can readily be produced on any screw-cutting lathe when desired.

In the metric system, on the contrary, a progression of diameters by even millimetres is practicable only up to 10 or 12 millimetres, after which it advances by 2, 3, or 4 millimetres, according to the system which is used; in fact, in many cases the advance is not uniform in the same system. Thus, in the system of Delisle, used to some extent in Germany, the following successive diameters in millimetres show the entire absence either of decimal or bisecting system: 30, 32, 36, 39, 42 mm.

The pitch also, in many cases, shows a similar disregard of system, being very very generally in fractional parts of a millimetre, and, curiously enough, often in halves and quarters of millimetres, with utter neglect of the fundamental decimal feature which is supposed to be the metric cornerstone. It is not to be wondered, therefore, that many manufacturers have retained the Whitworth system, not because of any especial merit, but because some standard must be had, and there is no metric standard.

The system which bears the favourable recommendation of the Zurich commission may provide the much-desired standard, but it may also add but one more to

the sixteen systems now extant—we cannot say in use.

So far as profile of thread is concerned, that originally proposed by Sellers is recommended, the angle being 60°, the apex of the equilateral triangle being flattened by one-eighth of the altitude. The rounded profile of Whitworth is thus abandoned, as are also the angles of 55° and 53° 8′, recommended by Whitworth and by the Verein Deutscher Ingenieure, respectively. The decimal system, however, is cast to the winds, both as regards bolt-diameters and pitch of threads, the former advancing by single millimetres up to 12 mm., by two millimetres up to 24 mm., by three millimetres up to 48 mm., and by four millimetres thereafter; while the latter advances by half and quarter millimetres from one up to seven millimetres.

This is practically the system previously proposed by the Société d'Encouragement, with the slight modification of the introduction of the quarter- and three-quarter-millimetre advance in pitch for certain of the sizes; under the circumstances it is probably the best that can be done. The commission evidently foresaw that other diameters might be desired; hence it is provided that any intermediate diameter may be used between those given in the regular series, the pitch of the nearest lower diameter being used in such cases.

Whether the new system will come into general use or not remains to be seen. It has been shrewdly remarked, in reference to the somewhat similar subject of gauges for the thickness of sheet-metal, that it is very much easier universally to adopt a new system than it is universally to throw away an old one, and we apprehend that the discarding of the systems now in use will not make very rapid progress, in view of the experience of the past.

High Speed Compound Locomotives.

DURING the past year a very complete series of tests has been made on the Northern Railway of France upon the new type of four-cylinder compound engines designed for high-speed service by M. du Bousquet. The detailed report of these tests has been given in recent issues of the *Revue Générale des Chemins de Fer*, and an excellent *résumé* by M. Barbier appears in *Le Génie Civil*. The completeness of the tests will be appreciated when it is understood that more than four hundred diagrams were taken at speeds ranging from thirty-seven to seventy-five miles per hour, together with corresponding readings of a traction dynamometer, for various positions of throttle and degrees of cut-off. The boiler pressure was maintained uniformly at about 215 pounds per square inch (15 kilogrammes per square centimetre), and every precaution taken to render the trials more complete than any which had hitherto been made.

The general construction of the engine may be briefly given. Of the four cylinders, the outside ones are high-pressure, and are 13.4 inches bore by 24 inches stroke. The low-pressure cylinders are inside, the dimensions being 21.9 inches bore and 25.2 inches stroke, the Walschaert valve-gear being used in both cases. There are four coupled drivers, 83.2 inches in diameter, the forward pair being driven by the low-pressure cylinders, and the rear pair by the high-pressure cylinders, and, of the total weight of 50 metric tons, 31 tons is upon the driving wheels. The cranks of each pair of high- and low-pressure cylinders are placed at an angle of 180° with each other, while the cranks on opposite sides of the engine make an angle of 90°. The boiler contains 107 tubes, 12 feet 10 inches long, and 2.54 inches in internal diameter, and the total heating surface is 1,885 square feet, of which 122 square feet is fire-box surface and the remainder in the tubes. The grate area is 23 square feet.

An examination of the combined indicator diagrams from both sets of cylinders, taken at moderate and high speeds, shows a number of points of interest, which may be taken as belonging to compound engines in general as adapted for locomotive service, since this engine represents general compound practice without any peculiar innovations.

The loss of pressure between the boiler and the initial pressure of the high-pressure cylinders appeared as a direct function of the opening of the throttle and an inverse function of the speed, and averaged from 30 to 35 pounds per square inch, or about one-sixth of the boiler pressure. This includes both the wire-drawing action of the valves and the initial condensation in the cylinder; and in this connection it may be noted that the expansion curve was in all cases below the isothermal.

As each cylinder was provided with its own valve gear, and the relative degree of expansion could thus be changed, it was possible, during the trials, to investigate the influence of changes of cut-off in the high- and low-pressure cylinders. An increase of speed, as a rule, caused a reduction in the total area of the diagrams, while a wider opening of the throttle increased the area. When the high-pressure valve gear was notched up to an earlier cut-off, the correspondingly-increased compression caused an increase in the receiver pressure, which again appeared in the low-pressure cylinders, while a later cut-off produced a lower initial in the low-pressure cards, but a greater area.

The trials included attempts to attain successively three different results: first, an equal division of work between the high- and low-pressure cylinders, as conducing to minimum wear; second, the production of the maximum power; and, third, the attainment of the greatest economy of steam.

In regard to the first point, it was found to be secured practically when the degree of cut-off was the same in both cylinders, the relation varying but slightly with changes of speed. The maximum power, however, as shown by the diagrams, was attained by prolonging the admission in the low-pressure cylinder. At speeds of sixty miles per hour an increase from 0.45 to 0.70 in the low-pressure cylinder, with a fixed cut-off at 0.45 in the high-pressure cylinder, showed an increase in power from 930 h. p. to 1,080 h. p. A similar relation appeared to exist as regards steam-consumption, and careful computations of power developed for steam consumed showed that the best economy was secured by permitting the steam to follow the low-pressure piston for the greater portion of the stroke, the cut-off in the high-pressure cylinder remaining constant. Under these conditions the steam-consumption per effective horse-power-hour was 25.5 pounds, at a speed of 37 miles per hour, and 40 pounds, at a speed of 75 miles per hour.

In practice it was found that the best results were obtained with the throttle about two-thirds open, the wire-drawing thus obtained partially superheating the steam and removing all "hammer-blow" action in the pipes. As a result of these trials, it appears that for high-speed compound locomotives of this type the best ratio between high- and low-pressure cylinders is 1 : 2.4.

The favorable impression made by the performance of this type of locomotive is shown by the fact that twenty additional engines of the same design have been ordered by the Northern Railway of France, to be used in the express service, which now has the reputation of being the fastest on the continent.

The Riga-Kherson Ship Canal.

Some months ago the proposition to construct a ship canal connecting the Baltic to the Black Sea was noticed in these columns, and a further account of the project is now given in a recent issue of *La Revue Technique*.

The present is undoubtedly a period of interest in ship canals, the advantages of such great waterways being more and more generally appreciated. Some of these are intended only to permit loaded vessels to reach manufacturing centres without breaking bulk and re-handling cargo, others are intended to shorten sea routes by cutting through isthmuses, while still others are projected to effect communication between lakes and inland seas, all having for their main purpose the extension of that most economical mode of communication, water transport.

The extent to which this subject has been developed in recent years, may be

indicated by a brief reference to some of the more important waterways which have been constructed or are now in course of construction. In England, the Manchester Ship Canal; in Germany, the Baltic Canal; in Belgium, the canals from Ghent to Terneuzen, from Bruges to Heyst, and from Brussels to Rupel; in France the canals from Caen to the sea, of Saint Louis, and of the Loire; and in Japan, the canal from the sea of Japan to the bay of Osaka.

In addition to these there are numbers of important internal waterways in course of construction all over Europe, which, while not to be included in the list of ship canals, yet indicate the great technical and commercial interest which is being taken in the transport of merchandise by water.

The latest, and greatest of these waterways, if measured by extent, and second only to the piercing of the American isthmus, if reckoned by importance, is the great work proposed in Russia, to which reference has already been made. As indicated on the map, it appears that between the slope of the Carpathians and the high lands of Valdai and Koursk, there exists a depression, which at no point reaches a greater altitude than 120 metres above the sea, and within which are found the Duna, the Dnieper and the Beresina. The Duna flows northward into the Baltic, while the Beresina flows into the Dnieper and the latter into the Black Sea. The head waters of both these systems are found in the low lying land between the mountains, and the proposed plan includes the canalisation of both streams and their connection into one continuous waterway by an artificial channel.

By thus using two navigable streams, having their origin in the same moderately elevated valley, the peculiar result is attained of a canal without locks in spite of the fact that there is a difference in altitude of 120.79 metres between the extreme levels. The conditions in this respect are somewhat similar to those found in the canalisation of the lower Danube, in which the canal constructed by the side of the cataracts of the Iron Gates converts a succession of waterfalls into a gradual slope without locks, merely by enclosing a portion of the stream between two longitudinal dykes, and extending the fall over a sufficient length to keep the velocity within reasonable limits. This method of construction is especially applicable to the proposed canal from the fact that the country between the Beresina and Meritza contains an abundance of water, and very moderate slopes. By the construction of movable dams and weirs it will be possible to control the water supply for the canal in such a manner as to maintain practically a uniform current, while any excess will be available for purposes of irrigation.

A large portion of the work will consist in the dredging of the beds of the rivers and the control of the channels by the limitation of the flow of water by embankments, while at the terminal ports of Riga and Kherson great docks, 300 by 200 metres are to be built. The two lakes of Beresina and Pripet are already centres of a vast grain trade, while numerous towns along the rivers furnish ports awaiting development.

The commercial advantages of this canal are not limited to the through traffic, although it is estimated that this would attain 10,000,000 tons per annum. It is rather anticipated that such an internal waterway would provide a means for extensive local transport of grain and other merchandise, assist in the development of coal and other mineral resources, and provide for the drainage of a large area of marsh land.

The estimated cost of the work is 500 million francs, of which 80 million are for expropriation damages, 228 million for dredging and excavation and 72 million for embankments, this sum to be raised by an issue of bonds guaranteed by the government, bearing 3 per cent. interest, and running for a term of 70 years.

There are many points for serious consideration about such an extensive project, not the least of which is the uncertainty of the immediate attainment of sufficient traffic to meet the interest charge on such a large initial cost. The constructive difficulties are by no means insuperable, and the military value of the canal is ample inducement to the government to insure

its completion should the work be definitely undertaken. It must not be forgotten that the canal would be closed to traffic at least three or four months in the year by reason of the cold, and that the bulk of the profitable use of the waterway must be concentrated in a period of about six months.

The Kornhaus Bridge at Berne.

NEARLY two years ago the commencement of work upon the great Kornhaus bridge across the valley of the Aar at Berne was noted in these columns, and now we have to notice the completion of the work as described in a very fully illustrated paper in the *Zeitschrift des Vereines Deutscher Ingenieure.*

The promontory upon which the old city of Berne was originally placed has long since been outgrown and upon all sides of the loop of the Aar have grown up suburbs which require ready communication with the old town. The stone arch of the once famous Nydeck bridge was the first attempt to provide a high-level roadway, and this was followed by the railroad bridge, the Kirchenfeld bridge, and the present structure, which since it extends from the Kornhausplatz to the Spitalacker, is known by the name of the former place; besides which there is the Lorraine bridge, as yet uncompleted.

The finished Kornhaus bridge does not differ materially from the description given in these columns in November, 1897, the total length of nearly 1200 feet being composed of four arches on one approach and one on the other side, each of 118 feet span, and the one great steel arch of 407 feet clear span over the Aar. On each side of the river rises a masonry pier over a hundred feet high, the main arch springing from the bases of the piers, and the approaches extending from them to the banks between smaller piers.

Owing to the manner in which the ground beneath Berne and its surroundings is permeated with ground-water, much difficulty was experienced in securing satisfactory foundations in the sloping banks for the great piers, it being necessary on one side to excavate to a depth of over 90 feet in the sliding moraine before a bearing in solid rock could be secured.

Many interesting details are given showing the manner in which the difficulties of construction and erection were overcome, and the whole work forms a good account of a form of bridge construction which is greatly in vogue at the present time.

The completion of this fine work leaves only the Lorraine bridge to be finished in order that Berne may possess fine examples of both steel and masonry arches, and a visit to the capital of Switzerland will soon be a pilgrimage of instruction for all who are interested in this branch of engineering.

Public Works in Paris.

THE condition of the city of Paris at the present time is that of general upheaval, and in the technical journals may be found ample evidence of the progress of the important engineering works which are now being pushed forward with energy.

Prominent among these are the works directly connected with the coming exposition, while others are indirectly due to preparations for the same event. Among these latter are included the Metropolitan Railway, the new terminus of the Orleans railway on the Quai d'Orsay, and the Alexander III bridge across the Seine.

A recent issue of *Le Génie Civil* contains interesting accounts of the progress of work upon the last two undertakings, with many illustrations showing the existing conditions.

The construction of the Orleans station is especially interesting as it includes the demolition of the ruins of the Cour des Comptes, which had been standing since the fire in the days of the commune. The principal difficulty encountered in this work was the danger in levelling the tall walls without floors, and it was found necessary to proceed at first with extreme caution in order to avoid accidents. The demolition was begun in April, 1898, and completed in August, and of the 30,000 cubic metres of material removed in four months about 10,000 cubic metres of cut stone were found available for use in the new structure.

The removal of all this débris, as well as of the material excavated from the site to provide the space for the lower train floor, required special arrangements, as no interruption in travel on the surrounding streets or on the Quai d'Orsay was permitted. A subway was therefore made under the quay leading to the bank of the river and through this tunnel the earth and material has been removed to barges. In constructing this passage it was found necessary to cut partially into the large collecting sewer which passes along the side of the river under the quay, and the floor of the tunnel at this point is supported upon I beams. In conducting the excavations the massive foundations of the old building were uncovered and revealed the solidity of the old work.

The site now exhibits an appearance of great activity, work being pushed forward by day and night, and it is expected that the foundations for the railway tracks, station, and terminal hotel will be completed by the end of January, 1899, after which the erection of the superstructure will proceed rapidly. In the meantime the prolongation of the subway beneath the quay along the left bank of the Seine is being carried forward, so that by the time the new station is completed the connection with the old terminal at the pont d'Austerlitz will be made.

The work on the Alexander III bridge is now making satisfactory progress, the great caissons of the piers for the arch having been sunk to rock foundation and the masonry work required to resist the thrust of the arch practically completed.

The false works for the support of the hinged arch during erection are now in place, and are so arranged that navigation in the Seine is not materially interrupted; there is every reason to believe that this handsome addition to the bridges of Paris will be completed as originally intended by the close of 1899.

Russian Railways in Asia.

THE value of the railway as a means of penetrating new countries is fully appreciated by the Russian government, and a paper by General Annenkoff in the *Bulletin of the International Railway Congress* describes in a very interesting manner the construction of the Transcaspian railway. This road, which extends from the Caspian to Samarkhand, was constructed primarily as a military railway, but has proved a most efficient civilizer and, by bringing the towns in the interior of western Asia into communication with Europe, has promoted commerce to a marked extent.

The constructor of the line had originally intended to dispense with manual labor as much as possible and use machinery, and with this object in view he ordered machinery from America. This idea, however, fell through when the natives found how much they could earn at the piece rates offered by the constructor, and the large number of capable men who offered their services made it possible to conduct the work by manual labor so rapidly and cheaply that the use of the machinery was practically abandoned. The general control of the work was in the hands of Russian soldiers forming what are called railway regiments.

These railway regiments had been organized on the following principle: the regiments received into their ranks recruits who, before being called upon to serve, had been educated in technical schools, in railway schools, in the schools of mines, forests, or metallurgy; they recruited also mechanics, blacksmiths, locksmiths, and carpenters.

Among these men were many who were capable of superintending railway-construction work, and with these and with the native laborers a very efficient force was obtained.

The general account of the manner in which the detailed work was executed with this peculiarly-organized body of men forms a most interesting chapter in the history of railroading, and it may prove of much value to other nations who have to use the railway as a civilizer. Not only was the construction of track over level country readily and cheaply accomplished, but such work as the erection of the bridge over the Oxus was executed in a satisfactory manner.

"A railway is a potent factor, not only towards occupying a country and aiding in its colonization, but also towards stimulating imports and exports if there is a native industry already in existence there.

"The wealth of the country beyond the Caspian lies in its cotton; the line was no sooner open than the Transcaspian railway began to bring in all the products which central Asia stands in need of, and to carry away towards the Caspian all the unmanufactured produce of the country.

"Russia imports cotton to the extent of 100 million roubles worth, and this used to come from America, Egypt, India, and central Asia. Of this, before the Transcaspian railway was built, only 800,000 roubles worth used to come from central Asia, but now half the cotton used in Russia comes from there.

"Accordingly the Transcaspian, which was built on military and political considerations, has led to an economic revolution, for it renders it possible for Russia to use a product coming from its own possessions instead of importing it from abroad."

On the plains where, during the Crimean campaign, the Tartars used to stop the advance of the Russian troops by setting fire to the standing grass, are now found populous and wealthy cities—many of them with a population exceeding 100,000. The same thing will happen in the steppes of central Asia and the Transcaspian district, but the railway will effect in a few years changes which in the other case took a hundred.

Compression in Steam Engines.

THE researches which have been made into the true action of the compression of steam in the clearance spaces of steam cylinders by Professor Dwelshauvers-Dery have been reviewed in these columns from time to time, and now we have to notice a further communication by him upon the same subject in the *Revue Universelle des Mines.*

The original trials conducted by Professor Dwelshauvers-Dery were made upon his experimental engine at the University of Liége, operating non-condensing, and the results appeared to prove that compression is not only of no benefit, but is, in fact, a source of loss. This result is so entirely opposed to what has been previously considered to be the case that the data of the tests have been examined and discussed by engineers in various countries, and Professor Boulvin of Ghent has especially attacked the conclusions as to the wastefulness of compression by endeavoring to show that the losses were really due to leakage, and that the theoretical investigations made by him demonstrated the truth of Zeuner's dictum that a compression of exhaust steam to the initial pressure nullified the injurious effect of clearance.

In order to meet these criticisms Professor Dwelshauvers-Dery has carried out a new series of trials, using the engine both condensing and non-condensing, and his discussion of the results of the later tests is now given to the public.

The data of the tests are examined very fully, using Hirn's analysis, and the results tabulated. The compression in these trials ranged from one-tenth to six-tenths of the stroke, the clearance and speed remaining constant.

The results fully confirmed the previous trials and, whether the engine was run with or without condensation, the experiments showed that the theory of the economy of compression was not borne out by the facts. Thus with one-tenth compression the steam consumption was 10.48 kilogrammes per horse power, with four-tenths compression 10.96 kilogrammes, and with six-tenths, 12.75 kilogrammes, there being an increase of 21.5 per cent. in the steam consumption between one-tenth and six-tenths compression.

A similar relation appears upon inspection of the indicator diagrams, it being plainly apparent that, after the compression attains a certain point, the pressure falls as the space diminishes, the effect of cylinder condensation being seen in the sudden hook formed at the end of the diagram.

This latest contribution to such an important question in steam economy will doubtless call forth further responses from those who hold contrary views.

In commenting upon this subject *The Engineer* calls attention to the fact that careful trials in the United States by Professor Jacobus show little or no variation in economy for varying degrees of compression, while other tests, both in America and in Germany, show gains with a moderate increase in compression.

Under these circumstances it is greatly to be desired that comparative tests by a number of skilled observers be made along the same lines as those adopted by Professor Dwelshauvers-Dery and that this important matter be settled upon a definite basis.

A Trans-Saharan Railway.

WHILE British industry and military prowess are united in clearing the way for a railway "from Cape to Cairo" there is being discussed in France a similar enterprise in another direction, and in the *Moniteur Industriel* is given an account of a proposed railway across the Sahara for the purpose of strengthening the French colonial possessions in Africa.

This important project had its origin more than twenty years ago, at which time it was considered solely from a commercial point of view; the great cost of the work, some 800 to 900 million francs, led at that time to its abandonment.

At the present time, however, other interests than those involved in commerce are to be considered and, in view of the growing strength of England in Africa, the construction of a railway crossing the desert of Sahara, and uniting the French colonies of Algeria and Tunis with the fertile country about Lake Tchad, is urged as a political and military necessity.

There is now a railway about 250 kilometres long from the port of Sfax, on the Mediterranean, to Gafsa, in the interior of Tunis, where a valuable deposit of phosphate rock is found, from which annual shipments of over 300,000 tons are now made. The general conditions of railway construction in this country are well-known, and it may be assumed without serious error that the prolongation of the Sfax-Gafsa railway across the desert could be made at about the same cost per mile as that portion already built. The climate is about the same, water is found at frequent intervals, and the topography does not greatly differ from that of the existing railway; It may therefore be estimated that the entire 2,000 kilometres could be completed at the cost of 60,000 francs per kilometre, including rolling stock, or a total of 120 million francs; and, even if this amount be increased by one-half to provide for unforeseen contingencies, it is yet far within the estimate of twenty years ago, which reached the enormous sum of over 800 million francs.

Apart from the strategical value of such a railway, there is some probability that its construction would have the effect of developing very materially the natural resources of the country through which it would pass. As a matter of fact, the real value of this portion of Africa is but imperfectly known. It is but a short time since the phosphate deposits of Algeria began to be worked, and even now, with proper transportation facilities, the present output of these beds could readily be increased to over a million tons per year. For some time there has been reason to believe that there exist in the interior of the Sahara important deposits of nitrates, which only need accesibility to rival those of Chile, and there are salt deposits already known to be awaiting development on the Soudan frontier.

These sources of traffic, however, are almost entirely in prospect; there is every reason to assume that the primary reason for the construction of a railway across the desert is that of extending, and at the same time consolidating, French power in Africa, and meeting the British colonial expansion in that continent by anticipating her in railway construction.

It is especially interesting to the engineer to note that in the attacks which are being made by nearly all the nations of Europe for permanent territorial hold in Africa, engineering work is depended upon as a more certain and enduring form of attack than military power, and that the railway, canal, and harbor are the real weapons in the conquest of a continent.

THE AMERICAN PRESS

Review of Leading Articles

The Mechanical Plant of Commercial Buildings.

AMONG the papers presented at the recent convention of the American Society of Mechanical Engineers that of Mr. W. H. Bryan, upon the mechanical plant of a modern commercial building, elicited much interesting discussion. It seems to be clearly recognized, in the United States at least, that such buildings are essentially engineering structures, in respect not only to questions of foundation, framework, and constructive details, but also to mechanical, steam, and electric plants, as well as plumbing and sanitary arrangements, all of these calling for engineering skill of the highest order.

In a modern American commercial building the mechanical plant is called upon to perform many important services, these being broadly included in the warming and ventilating, the lighting, and the transportation both of persons and merchandise.

This work involves the installation of a steam-power plant—including boilers, engines, piping, and transmission, together with provision for handling fuel and ashes—as well as a complete electrical plant, both for lighting and power. The transportation above referred to includes the operation of elevators, which, unless operated electrically, necessitate the installation of hydraulic power. All this machinery must, as a rule, be erected and operated in a much more contracted space than that which would be allotted to similar service in a manufacturing establishment.

The distribution of these various functions differs according to local conditions, and one of the most interesting portions of the discussion was that which was brought out by the practice of engineers from various parts of the United States.

In the southern States (the building discussed in the paper is in St. Louis, Mo.) the question of power is found to be the most important feature, while in New York and Boston the colder climate renders the warming of more consequence. In every case the lighting consumes a large portion of the electric current, while electric motors operate most of the machinery required.

Mr. Bryan divides the mechanical plant of a building into the following groups:

The steam boiler plant, including furnaces, brickwork, smoke flue, etc.

The elevator system, either hydraulic, electrical, or steam.

Dynamos and switchboard.

Steam engines for driving the dynamos.

Wiring, cables, arc and incandescent lamps, motors and fans for ventilating.

Steam-heating system, including the piping directly involved.

Large and high-pressure pipework including connections between boilers, engines, free exhaust, etc.

In order to avoid the controversies which frequently arise about the rated capacity of boilers based upon heating surface, Mr. Bryan adopts the plan of stating the quantity of steam required to generate the power, perform the heating, and meet the requirements generally, the weight of water per horse power being variously taken as 100 pounds per h. p.-hour, for the least economical pumps, etc., down to 28 pounds per h. p.-hour for compound engines driving dynamos, and an evaporation corresponding to the aggregate quantity of water thus computed being required of the boilers, leaving the responsibility of the proportion of heating-surface with the maker.

The low economy of steam or hydraulic elevators has become a matter of so general consideration that electric elevators were chosen; in this connection it is worthy of note that the cost of operation of the electric elevators ranges, as tests show, from one-half to one-third that of good hydraulic lifts, according to the economy of the pumps used for the latter.

Water-tube boilers, with so-called

"down-draught" furnaces, were installed, and, although no extraordinary evaporative results have been attained, the freedom from explosion, and the comparative absence of smoke-production, are desirable features which have been secured.

The remaining details of the plant described in Mr. Bryan's paper call for no especial comment, but the entire treatment of the subject, together with the animated discussion which followed, showed the important extent to which this branch of engineering occupies the practice of specialists.

In some architects' offices at the present time there are engineering members of the firm, the whole work, including both design and construction, being controlled in the office of the architect; but in by far the greater number of instances the service of special engineers is called in, and the work of the architect, for commercial buildings at least, is being more and more closely limited to questions of external appearance, both the structural work and the interior equipment being turned over entirely to the engineer.

Torpedo-Boat Destroyers.

AMONG the papers discussed at the recent meeting of the Society of Naval Architects and Marine Engineers was one by Mr. G. W. Dickie on the subject of torpedo-boat destroyers; it is worthy of especial attention, both by reason of the unsettled position of this class of craft since the experience with the Spanish destroyers, and because of Mr. Dickie's standing in the profession and the freedom with which he expresses himself.

The primary function of the destroyer is that of overtaking and destroying the torpedo boats of the enemy. Heretofore it has been assumed that this requirement was met by making the destroyer swifter and more heavily armed than the boat to be destroyed. Mr. Dickie, however, shows, in the first place, that there are other functions almost as essential as speed and armament, and, in the second place, that the recorded speeds of the boats to be destroyed are largely fictitious.

"A torpedo-boat destroyer must possess other qualities than those necessary for the destruction of torpedo-boats. In fact, the destroyer must be a sea-going vessel, able to remain at sea with the fleet to which she is attached, or to make independent voyages.

"The work of the torpedo-boat destroyer is to prevent the torpedo-boat attack, and is therefore performed in open water. She must keep the sea with the attacking fleet, watching every place of refuge for a torpedo boat. She must, therefore, possess speed equal to that of the torpedo-boat; a battery powerful enough to destroy her; sea-going qualities to enable her to keep a watch in spite of weather. She should be able to cover long distances at a high rate of speed and in stormy weather. The fleet to which she is attached should not be delayed and hampered by guarding her from harm; she ought, instead, to be able in all kinds of weather to act as a scout in advance of the fleet, keeping the larger vessels informed as to the whereabouts of a possible enemy. Such would be the ideal torpedo-boat destroyer."

If these requirements are to be met, much more substantial craft than the present destroyers must be built. On the Pacific coast especially—the waters Mr. Dickie had principally in mind—the distances to be traversed make thorough sea-going qualities imperative, and a destroyer capable of making the voyage to Honolulu from San Francisco at a speed of 15 knots, or to Puget Sound or San Diego at 20 knots, as he proposes, ought to be fit for any waters elsewhere on the globe.

Such a result, however, cannot at present be attained, if the weight and power be so proportioned as to make a maximum speed of 30 to 31 knots possible; so the destroyer proposed by Mr. Dickie, with a total load-displacement of 800 tons, and engines of 7,000 h. p., is intended to have a maximum speed of only 25 knots. This speed, however, is intended to be one which can be maintained for hours together, not only on trial, but at any time thereafter when it may be needed,—not as a mere spurt, but upon demand.

It is well known that torpedo boats, or,

indeed, any other naval vessels, rarely equal their trial speed thereafter.

A large proportion of naval vessels rated at high speeds, especially those of a rate exceeding twenty knots, have obtained such speeds under conditions that cannot be reproduced when the speed is most needed, and a good, reliable, heavy-engined sixteen- or seventeen knot boat may outstrip them in a fight.

"Whatever speed a fighting ship has ought to be produced when ordered from the bridge. An Atlantic liner would not be considered a success if in ordinary weather she could not cross the ocean at very near her trial speed, and, if the machinery of a naval ship were as substantially built, she could do the same, if necessary, as long as her coal held out." That this can be done with naval vessels has been abundantly proved by the manner in which the Oregon practically equalled her trial speed at Santiago immediately after her long voyage around the Horn, and it may be of interest to remember that the Oregon was constructed in the yards of which Mr. Dickie is and was in charge.

Judging from the condition in which nearly all the torpedo boats of the United States navy were found after the brief service of the Spanish-American war, there seems to be little doubt that a destroyer built along the substantial lines indicated by Mr. Dickie would have no trouble in overhauling and disposing of any of them.

As Mr. Dickie himself says, the vessel which he proposes is "a sea-going torpedo-boat destroyer that can go to sea and remain at sea without any special risk, and at sea can maintain a speed of twenty-five knots for a few hours when such a speed is required; that can make extended voyages, thus serving the purpose of a scout or dispatch-boat, whenever or wherever such service is required; that carries a battery that makes her a torpedo-boat destroyer in fact."

Such a boat would show better speed under regular service conditions than any of the so-called thirty-knot torpedo-boat destroyers, and, for seaworthiness, habitability, or fighting capacity, far outrank the best of them.

Electrolysis of the Brooklyn Bridge.

PERHAPS the most unexpected discovery made in connection with the great extension of overhead-conductor electric railways is that the return currents from the moving cars often seek buried metals, such as water and gas pipes, and, in more or less time, cause their destruction by electrolytic solution. The dangers to which buried pipes are thus subjected have caused the passage of strict municipal ordinances in the United States, and the matter has been made the subject of parliamentary regulation in the United Kingdom. So far, the injurious effects of these earth-currents have been investigated with reference only to pipes, but the well-established injury wrought upon these is beginning to cause fears for the safety of certain other subterranean metallic structures. In a long paper read before the last meeting of the American Institute of Electrical Engineers Mr. A. A. Knudson gives the results of a series of measurements of electrical potential between various rails and pipes in the borough of Manhattan, and concludes with some highly-interesting measurements of electrical pressures at various points of the New York and Brooklyn bridge. These show that, while the bridge is probably in no immediate danger, the electrical condition of the anchorages will bear watching.

The measurements of potential show that all over Manhattan island a slow destructive action is going on, embracing not only water and gas pipes, manholes, etc., but the vertical members of the elevated railway structure as well. It is demonstrated that the influence of an overhead-trolley line of only ordinary activity extends for more than a mile, and that the whole lower end of Manhattan island is permeated by earth-currents having their origin in the extended overhead-trolley system of Brooklyn. These currents seem to cross the East river by the bridge cables, and to ramify through the pipes, etc., beneath the surface of lower Manhattan, finding their way back to Brooklyn at a number of points along several miles of the river front.

The cables of the bridge are anchored to heavy cast-iron plates imbedded in masses of cut-stone masonry laid up with cement in the most substantial manner. The author concludes that, although these anchor plates are only a few feet above mean high-water-level, and some nine hundred feet back from the water-front on each side, there are no conditions present favorable to electrolytic action.

Just how this can be reconciled with the passage of a large current *via* the bridge from the Brooklyn side is not made clear. The fact that such a current does cross the river, and in sufficient amount to make itself evident over more than a square mile of the lower part of Manhattan, seems to be well demonstrated. Wherever the current leaves a metal in damp earth,—that is, where the metal is positive to the ground,—there will be electrolytic solution. The amount of this is definite, provided the conduction from the buried metal is electrolytic, and not due to the specific conductivity of the materials in which it is buried. As the bridge anchorages are bedded in a mass of stone and concrete, only a short distance away from salt water, and as both these substances are fair insulators, it is reasonable to assume that the only way in which the current can leave the anchor plates is by electrolytic conduction through such water and salts in solution as may be present.

Should this be the case, the metal parts of the anchorage will inevitably be dissolved, unless the electrolytic action is stopped. Unfortunately the anchorages are not accessible for examination, so that no theory of what is going on can be put to the test; but certain simple preventive measures might well be taken, and, whether or not the danger is real, would certainly have no harmful effect. Another conclusion which Mr. Knudson draws is that there is absolutely no perceptible outflow of current from the new conduit railway systems in New York. While this fact is not unexpected, it is gratifying to know that actual tests demonstrate that there can be no possible electrolytic action following the installation of a railway of this sort.

Architectural Acoustics.

THE acoustic properties of public auditoriums have as yet received but small attention in proportion to the importance of the subject, and in very many, if not most, cases architects appear to leave the matter entirely to chance. If a hall chances to develop good acoustic properties, it is considered a very fortunate occurrence, and, if not, some crude attempts may be made to improve matters, or the effort may be given up as hopeless.

A paper upon this subject, by Prof. W. C. Sabine, presented before the American Institute of Architects, and printed in full in the *Engineering Record*, contains a careful discussion of the problem in the light of the best information at present available, and, while it shows that the complexity of the subject renders a practical treatment extremely difficult, there are some important points a knowledge of which may be made of service in actual construction.

In the case of a speaker in the open air, the sound spreads in all directions; while there are no reflections or obstructions, much of the effect is wasted by the passage of the sound to points where there are no hearers. A wall placed behind the speaker will reflect a portion of the sound, and side walls and a ceiling will return still more. A portion of the sound will be reflected and a portion absorbed, according to the nature of the surface. When the distance and location of the reflecting surface are such that it will reinforce the sound to the audience, the material should be made as good a reflector as possible; but in many instances the sound returns only in time to make a confusing echo, in which case the surface from which it comes may be made absorbent.

Concerning the shape of the room, there are no positive rules which can be given, although certain general principles exist. "A wall immediately behind the speaker, angle walls cutting off the corners at each side, and a sloping ceiling, not high, immediately above him, are advantages. A curved ceiling over the audience, or one with sloping sides, is favorable." There is no advantage in the use of the ellipse or

of any conic section with the speaker at the focus, and there is no simple geometrical surface ideal for the purpose, the many variables making the problem altogether too complex.

One of the difficulties in connection with the reinforcement of sound by reflection lies in the manner in which sound waves interfere with each other, the differences in the distances traversed by the waves reflected from various parts of the room causing the sound to be strengthened at some points and weakened at others. Professor Sabine shows how careful tests at the Harvard Physical Laboratory demonstrated the existence and nature of this action, but as yet no general cure for it has been devised, although in certain cases success has been obtained.

The principal feature in the problem, which has been treated in a practical manner, is that of the absorption of sound by surfaces from which reflection would be undesirable. In many cases, especially in empty, unfurnished rooms, the audibility of a sound will persist to such an extent as to interfere materially with the succeeding sounds. By the use of an electric chronograph it has been found possible to measure the rate of absorption of sound for a given room under various circumstances, and the influence of various kinds of hangings and upholstery can be very clearly shown. Similar effects are produced by the presence or absence of an audience, and, in order that the acoustic properties of a hall may be the same when only partially filled as when full, the vacant seats should be provided with cushions of equivalent absorbent value.

There are thus three factors in the problem,—loudness, interference, and distinctness; and the solution, like that of most other complex problems, must be a compromise. Interference is usually less noticeable than either deficient loudness or excessive residual sound. Residual sound can be reduced to the minimum by inclining the reflecting surfaces in such a manner as to bring all the sound by one reflection upon the audience, the latter being the most absorbent factor in a room. This will also raise the loudness to the maximum, both ends being thus attained together.

The principal difficulty lies in the fact that considerations of architectural design with regard to appearance must generally outweigh the desire for acoustic excellence; and, when æsthetic demands have been considered, and the requirements of lighting, heating, and ventilating fully met, the acoustic properties of a building have but small chance of consideration.

Professor Sabine's paper contains interesting details of tests and investigations of the acoustic properties of several buildings and rooms under various conditions, these probably being the first quantitative researches of this nature ever undertaken.

The Problem of the Gas Engine.

THE increasing interest which is being evinced in internal combustion motors is mainly based on the superior economy which it is thus possible to attain, but in spite of the demonstrated advantage in this respect the general introduction of gas or petroleum engines as substitutes for the steam engine does not appear to be imminent.

There are several reasons for this, and it is this phase of the subject which is discussed in a paper on the problem of the gas engine by Herbert L. Towle, in a recent number of the *American Machinist*.

The real problem of the gas engine lies in the peculiarly delicate conditions under which the combustion takes place, and it is not surprising that the equilibrium of these conditions should frequently be disturbed from causes which are not immediately apparent.

"We must remember that the cylinder is virtually a very small firebox with water cooled walls, that we have neither a bed of incandescent fuel, brick arch nor length of uptake, and that our gases are lighted and must burn themselves out from two to eight or ten times a second. The one thing, indeed, that renders these results possible is the compression which drives the vibrating molecules of gas and oxygen close together and preheats them before the spark or hot tube gives the quick ad-

ditional impulse to their velocity, which makes them meet and unite.

"From these facts, well known to designers, two conclusions follow. The first is that the most immediate need of the gas engine is neither higher economy (though this is not to be disregarded), for it is already more economical than its competitors; nor lower price, for it is on sufficiently even terms in that respect at present; nor better mechanical design, for this is a matter only of experience and judgment on the part of the designer; and in respect of lubrication, balancing, valve gears and the like, the best engines of to-day leave little to be desired; nor is it even better regulation, for regulation as steady as desired can be obtained without unreasonable sacrifice of efficiency by throttling the charge or dividing the power; but what the gas engine requires to make it a serious factor in the commercial world is that the elements of uncertainty connected with its chemical operation be reduced to the utmost minimum or abolished altogether. Desirable in any case, this becomes a necessity when it is put in competition with its less fickle rivals. The second conclusion is that, to abolish this uncertainty, the conditions affecting combustion must be subjected to positive and automatic mechanical control, so that it shall be impossible for them to vary without actual and sensible derangement of working parts. In proportion as this is accomplished, and only in proportion, does mechanical certainty take the place of conjecture, and reliability become a question merely of the number, intricacy and durability of the several parts. To achieve this then may at present be considered the chief problem of the gas engine.

The Work of the Engineer.

THE annual address of the retiring president of the American Society of Mechanical Engineers, Mr. C. W. Hunt, discussing broadly the important subject of the work of the engineer, forms a very interesting contribution to the general literature of engineering, and some extracts from salient points will be of interest here.

After quoting from Tredgold's definition of the engineer, as one who is skilled in the application of the materials and forces of nature to the uses of man, Mr. Hunt goes on to differentiate between the two classes of engineers, *i. e.*, the engineer of the user and the engineer of the maker, comparing the manner in which one must superintend the construction of work which is to be performed according to specifications drawn up by the other. In this connection he compares the difference in the practice of the United States and other countries, American practice tending toward specifications of a very general character, leaving to the supplier the work of designing the particular means to accomplish the desired end.

The important advantages given to the work of the engineer by the progress which has been made in laboratory equipment, as well as the benefits due to scientific societies are noted, and the rapid advance in American productive and commercial interests are very clearly set forth.

"It has long been evident that we are making rapid progress in perfecting our manufacturing machinery, as well as organizing and developing our industries, thus constantly increasing the efficiency of our labor, until we have lately reached a point where an hour's labor with its facilities produced more of our principal products, and transported them farther, than an hour's labor would do in any other part of the world.

"The late war has revealed to us the fact that we have gone on reducing the cost of our products, and increasing our capacity for production, until our country alone does not furnish a sufficient market to insure steady work for our labor, and prosperity for our merchants and manufacturers. Like confined waters, the tendency of these economic forces has been to break out from their confinement and equalize trade conditions by seeking a market in the world outside. If articles which are necessary to supply the wants of man can actually be made with less labor and cheaper here than elsewhere, here they will surely be made, though it modify our traditional ideas of isolated

position, and our protective theories. One hundred years ago the iron trade of Sweden was greater than that of England, and remembering the great changes which have taken place in the last hundred years, it would be rash to assume that the momentous economic changes which are now taking place, may not cause an equally great shifting of the centres of more than one phase of industrial activity."

The advent of the engineer into the work of daily life is noted as one of the features of modern conditions which indicate the transformation through which we are passing, and this is clearly shown to be a broad advance in general civilization.

From being a minor profession in the midst of many others of equal or superior influence, engineering has risen until it holds a place which commands practically the entire field of science and industry.

"Thus stands the engineer in the midst of a countless number of earnest explorers in the field of unrevealed nature, and so to speak, sees the tools forged and the materials discovered with which he is to work. Cheerfully can he enter upon his daily tasks with the consciousness that his application of these discoveries is of real service in lightening the burdens of life, as well as elevating and ennobling his fellow men."

The Fireproofing of Wood.

THE disastrous effects of the presence of a quantity of inflammable woodwork upon naval vessels in action was clearly shown by the manner in which the Spanish ships at Santiago were damaged by the combustion of their own material. With this experience in mind the United States bureau of construction has determined upon the use of fireproofed wood in the new battleships Maine, Missouri, and Ohio; and in a recent issue of *Engineering News* is given an account of the method of preparing the wood to be used on these vessels.

The general process resembles very much that of creosoting timber to preserve it from decay, the creosote being replaced by a solution consisting principally of phosphate of ammonia and sulphate of ammonia. As in the case of creosoting, the principal object to be attained is that of introducing the solution very thoroughly into the pores and channels of the wood. This is best accomplished by first opening the pores and replacing the natural juices with moisture, and then removing the moisture by evaporation.

The presence of steam at too high a temperature is apt to reduce the strength of the wood, and at the same time to seal the pores, thus defeating the object in view; but, if the timbers are placed in a closed cylinder, containing a few inches of water at the bottom, and low-pressure steam is introduced, it is found that the pores of the wood will be opened almost like those of a sponge, and the best possible preparation made for the reception of a foreign solution.

After the wood is thoroughly saturated with moisture, the second stage—that of evaporation—is begun by gradually inducing a vacuum in the cylinder, and thus exhausting the moisture from the pores of the wood, leaving them open for the entrance of the fireproofing liquid. The vacuum is broken about every three hours, to permit the accumulated moisture to be drawn off, and, after all the moisture has been removed, a final vacuum of twenty to twenty-eight inches is maintained, while the fireproofing solution is caused to fill the cylinder. To insure a complete filling of the pores of the wood, a pressure is applied to the liquid in the cylinder, and maintained until the wood is fully saturated.

The final process is that of drying the treated lumber, which solidifies the chemicals in the pores and leaves the wood in a condition for use. This drying should be performed at a moderate temperature, in order to avoid injuring the wood for constructive purposes, too high a temperature rendering it weak and brittle; in practice, a kiln temperature of 85° to 125° F. has been found suitable.

Tests have shown the strength of wood thus treated to be but slightly impaired, and, while it may be too much to say that it is entirely fireproof, yet it may justly be

claimed that it is non-inflammable. When it is exposed to flame, it will char, and, if the flame be continued, it will be completely carbonized, but it will not catch fire, and, when the source of heat is removed, it will not retain the flame. This is undoubtedly in conformity with the requirement of the United States navy department, which is that, "when dry and subjected to heat of 600° F., it will remain non-inflammable, and absolutely safe against spread of fire from point of contact."

Deflections of Railway Bridges.

THERE exists, among engineers, a wide difference of opinion as to the provision that should be made for the stresses due to moving loads on railway bridges, and as to how the allowance should be distributed among the different members of the bridge. In some specifications the element of fatigue of metals is considered, while in others the live load stresses are increased a certain percentage "for impact" and then treated as dead load stresses. Still other specifications take account of both fatigue and impact.

It seems logical that both fatigue and impact should be provided for if both exist, but before a formula can be deduced the two must be considered separately.

With the hope of contributing something to the solution of this problem, Mr. F. E. Turneaure conducted, during the summer of 1897, a most elaborate series of experiments on bridges of varying span, type and design, and embodied the results in a valuable paper before the American Society of Civil Engineers.

Two instruments were used, one for measuring and automatically plotting the deflection of the span, the other for similarly registering the extension of individual members under strain. Both are the invention of Professor Fraenkel, of Dresden, and consist of chronograph cylinders turned by clockwork under a pencil point arranged to greatly multiply the respective movements of extension and deflection. About three feet of the tension member under examination were embraced by the extensometer, while a steel wire, attached to a heavy weight on the ground below the span and kept taut, furnished the base for the indications of the deflection register.

Tests were made on twelve plate-girder bridges of spans varying from 25 to 80 feet, and eleven truss bridges of spans from 100 to 200 feet, on the Chicago, Milwaukee and St. Paul and Union Pacific railways. About 400 experiments in all were made, mostly with trains of the regular traffic, though a few were conducted with trains of light and loaded cars.

The results of the experiments are presented by the author in graphic form and with a great wealth of interesting detail. The conclusions drawn may be briefly summarized as follows:

Much vibration is not likely to result from speeds less than about 25 miles per hour. The increase in deflection, caused by locomotives running at speeds of 40 to 50 miles per hour, is likely to be 40 to 50 per cent. for girder spans of less than 50 feet length, but this percentage decreases rapidly for longer spans, becoming about 25 per cent. as a maximum for 75 foot spans. Owing, however, to cumulative effects, the percentage is likely to be a maximum of 20 to 25 per cent. for spans of 75 to 150 feet, or more, but the experiments indicate no increase of percentage for increase in span.

Chord stress is increased in about the same proportion as deflection, that in the center diagonal being somewhat larger, while in the hip vertical it corresponds more nearly to the deflection in short girder spans.

In the spans tested the effect of the speed of application of the load on the mean deflection was inappreciable (the increase in deflection from moving load being due to vibration) though theory points to an appreciable increase from this cause in short spans without camber.

In small girders with shelf-angles, and and in some parts of trusses, secondary stresses are likely to be high. The discrepancy between the computed and observed stresses may actually be greater from this cause than from the dynamic effect of moving loads.

THE ENGINEERING INDEX

INTRODUCTORY

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m* a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.
Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.

Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Glaser's Ann. f. Gewerbe & Bauwesen. *s m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m.* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc. of Engs. and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde. 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines, *m.* Liége.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Dusseldorf.
State's Duty. *m.* St. Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club. Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Architectural Engineering.

General Practice in Regard to the Employment of Electrical, Heating and Sanitary Engineers. H. G. Bradlee. Read before the convention of the Am. Inst. of Archts. Discusses the mutual relations of architects and engineers, presenting both sides of the question, and offering suggestions to overcome difficulties. 7000 w. Am Arch—Nov. 12, 1898. No. 23930.

Building Details.

Balanced Column Loads. Illustrated description of steel construction in an 8 story warehouse. 1200 w. Eng Rec—Nov. 26, 1898. No. 24225.

Bungalows.

Indian Bungalows. Plans of typical bungalows, describing and pointing out defects in arrangement, insanitary conditions, &c. 3800 w. Ind & East Engr—Oct., 1898. No. 24014 D.

Competition.

Report on the "Shattuck Prize" Competition for Artisans' Houses. The housing of fifty artisan households in the suburbs of a city was the subject of study. The designs presented are illustrated and discussed. 3000 w. Am Arch—Nov. 26, 1898. No. 24262.

Corfu.

Dwelling Houses in the Island of Corfu. (Wohnhäuser auf der Insel Korfu.) A. Meissner. A description of the island, and some accounts of the characteristic features of the local architecture. 1500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1898. No. 24123 D.

Design.

The "Bases of Design." Walter Crane. A review of this book with some of the most valuable points noted. 2300 w. Arch Rev—Vol. V, No. VII. No. 23844 F.

Domes.

The Theory of Construction of Domes and Spires. (Beitrag zur Theorie der Kuppel und Turndächer und Verwandter Konstruktionen.) H. Müller-Breslau. A very full theoretical and practical discussion of the structural work of domes, cupolas, gasholders and spires, with diagrams and photographs of structures. Two articles. 1200 w. Zeitschr d Ver Deutscher Ing—Oct. 29, Nov. 5, 1898. No. 24107 each D.

Fire-Proof Construction.

An Example of Fire-proof Church Architecture. Peter B. Wight. An illustrated description of the new St. Paul's (R. C.) church in Chicago, with interesting facts relating to its construction. 2300 w. Br Build—Nov., 1898. No. 24260 C.

Fire Resisting Floors. Frederick R. Farrow. Extracted from a paper issued by the British Fire Prevention Committee, and published in the *Railway Engineer*. Reviews the earliest attempts at the construction of these floors, and describes various forms which have been devised. Ill. 1800 w. Ry & Eng Rev—Nov. 26, 1898. No. 24266.

Special Fireproof Construction in the U. S. Appraisers' Warehouse, New York City. Gunwald Aus. Illustrated description of this large building, with special mention of the fire-retarding screen which encloses the light well. 1000 w. Eng News—Nov. 3, 1898. No. 23772.

Floors.

Ceramic Mosaic v. Marble Pavement. H. C. Mueller. Setting forth the possibilities of burnt clay for flooring. 600 w. Br Build—Nov., 1898. No. 24261 C.

Foundations.

Chicago Post-Office Foundations. Review of paper by William Sooysmith on the remarkable long-pile foundations of a 300x360 ft. building. Each pile carries 30 tons. 3600 w. Eng Rec—Nov. 26, 1898. No. 24219.

The Foundations for the U. S. Government Post Office and Custom House Building at Chicago. William Sooysmith. Gives a statement of the kinds of materials met with in constructing these foundations, and an illustrated description of the work. 4000 w. Jour W Soc of Engs—Oct., 1898. No. 23917 D.

Native Architecture.

Native Architecture in Africa and New Mexico. Illustrated description showing that similar conditions have caused a great similarity in the native architecture of these remote regions. 2000 w. Sci Am—Nov. 12, 1898. No. 23893.

Observatory.

The Observatory of Paris. J. Guénaire. Illustrated historical account, with some reference to the important work carried on. 2000 w. Sci Am—Nov. 19, 1898. No. 23973.

Opera House.

The Paris Opera House. Description, with illustrations, of the most remarkable modern edifice in France. 1400 w. Sci Am Sup—Nov. 12, 1898. No. 23895.

Oxford.

The Buildings at Oxford, From an Engineer's Point of View. J. W. Parry. An exceedingly interesting illustrated description of the ancient buildings of the various colleges of Oxford, with many curious details of construction methods, showing the expedients of architects and engineers before the invention of many of the present building methods and materials. 5000 w. Engineering Magazine—Dec., 1898. No. 24287 B.

Roman Construction.

Roman Construction. G. W. Percy. Describes and illustrates methods employed by Roman builders in constructing vaults and arches. Discussion. 4500 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23979 C.

HEATING AND VENTILATION.

Bank Building.

Ventilation and Heating of a Syracuse Bank Building. Illustrated description of the com-

bined direct and indirect heating plant in a 10-story building with special ventilation for the banking rooms. 1500 w. Eng Rec—Nov. 5, 1898. No. 23798.

Heating Surface.

Concentrated Heating Surface for Hot-Blast Systems. J. H. Kinealy. Describes the two general systems of arranging the heating surface of hot blast apparatus, and comments on cost and advantages. 1000 w. Heat & Ven—Nov. 15, 1898. No. 24083.

Hospitals.

The Ventilation, Heating, Water Supply and Drainage of Infectious Diseases Hospitals. E. R. Matthews. Read at meeting of Inst. of San. Engs. (England). Reviews the origin of these hospitals in England, mentioning important points in selecting a site, describing general structural arrangements, and precautions necessary in the lines mentioned. 2000 w. San Rec—Nov. 4, 1898. Serial. 1st part. No. 23956 A.

Hot-Water Apparatus.

The Dangers of Hot-Water Heating Apparatus. Gives especial attention to dangers arising from frost, illustrating by examples. 3300 w. Builder—Oct. 29, 1898. No. 23852 A.

Hot-Water Pipe.

English Views on the Cause of Noises in Hot-Water Pipe. Refers to hot-water apparatus which supplies baths and taps from a boiler in a kitchen range. 2800 w. San Plumb—Nov. 1, 1898. No. 23873.

Ohio University.

The Heating, Ventilating and Power System of Ohio State University. A. E. Hitchcock. A satisfactory solution of heating widely separated buildings, and for supplying power at any point, at small cost. Ill. 1500 w. Heat & Ven—Nov. 15, 1898. No. 24082.

School.

Heating the School at Pocantico Hills, N. Y. Illustrated description of the heating arrangements in a building consisting of one story and basement. 1100 w. Met Work—Nov. 12, 1898. No. 23908.

Station Heating.

Arrangement and Ventilation of the Providence Union Station. This station, one of the largest in the United States, is the result of 20 years' study. It comprises several detached buildings heated from a central plant, and its mechanical plant is illustrated. 2000 w. Eng Rec—Nov. 12, 1898. No. 23925.

Steam.

High-Pressure Steam Heating Plant. (Hochdruck Dampfheizungsanlagen.) H. Menz. Discussing especially the methods and devices for returning the water of condensation back to the boiler in high-pressure steam heating installations. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1898. No. 24125 B.

Subway Ventilation.

Ventilation of the Boston Subway. Description of a plant with electrically driven fans which change the air in the subway every 15 minutes. 600 w. Eng Rec—Nov. 19, 1898. No. 24024.

Ventilators.

The Computation of Screw Ventilators. (Ueber Berechnung der Schraubenventilatoren.) A paper by Herr Recknagel upon the computation of the discharge of ventilating fans of the screw disk type, giving formulas and application; also discussion. 2500 w. Gesundheits-Ingenieur—Oct. 15, 1898. No. 24127 B.

See Electrical Engineering, Heating and Welding.

PLUMBING AND GASFITTING.

Drainage.

The Effect of Recent Decisions on the Liabilities and Rights of Owners in Respect of the Drainage of Buildings. Alexander Macmorrow. Paper read at a meeting of the Auctioneers' Inst., England. Calls attention to important points that have been the subjects of recent decisions, showing what the British law requires. 2500 w. San Rec—Nov. 11, 1898. Serial. 1st part. No. 24038 A.

MISCELLANY.

Acoustics.

Architectural Acoustics. Illustrated paper, by W. C. Sabine, on the acoustic properties of auditoriums, and experiments made at Harvard University to determine methods of overcoming defective acoustics in halls. 4000 w. Eng Rec—Nov. 12, 1898. No. 23926.

Address.

The Advancement of Architecture. George Aitchison. Presidential address before the Roy. Inst. of Brit. Arch'ts. Considers the need of proper teaching to advance architecture. Discusses some of the points requiring study, and the subject generally. 5000 w. Brit Arch'ts—Nov. 11, 1898. No. 24036 A.

Architects.

The New Architect: His Work and Registration. Howard Pentland. Inaugural address to the Archt. Assn. of Ireland. Considers present architectural practice, and the necessary training of architects, comparing the work with that required at earlier periods. 5700 w. Builder—Nov. 5, 1898. No. 23961 A.

Architectural Engineering.

The Employment of Consulting Engineers by Architects. Abstract of paper by H. G. Bradlee, before the Am. Inst. of Arch'ts. 1500 w. Eng Rec—Nov. 5, 1898. No. 23797.

Cathedral.

Glasgow Cathedral. William J. Anderson. Review of a book recently edited by George Eyre Todd, giving the history and an illustrated account of the greatest fane of Scotland. 3000 w. Jour Roy Inst of Brit Arch'ts—Oct. 15, 1898. No. 23830 B.

Criticism.

Criticism Which Helps. C. H. Blackall. The relation of criticism to architecture, the impor-

tance in encouraging artistic growth, &c., with editorial comment. 4000 w. Arch Rev—Vol. V, No. VII. No. 23843 F.

Decoration.

Interior Decoration. W. H. Elliott. Considers some points essential to successful wall decoration. 1000 w. Can Arch—Nov., 1898. No. 23991 C.

Excavations.

Excavations in Thebes. John E. Newberry. Read at meeting of the Archt. Assn., London. Contains a description of the architecture and details of the Temple of Hatshepsut, now known as Deir-el-Bahari, with account of the work of excavating. 9000 w. Arch, Lond—Nov. 4, 1898. No 23957 A.

Forms.

Architectural Forms in Nature. F. S. Dellenbaugh. Interesting illustrated description of natural contours resembling buildings, bridges and other architectural structures. 3300 w. Ap Pop Sci M—Nov., 1898. No. 23721 D.

Modern Decoration.

Notes and Queries on Modern Decorative Design and Color. Alexander Rottman. Read at meeting of the Nat. Assn. of Master House Painters. Discusses British practice. 4500 w. Plumb & Dec—Nov. 1, 1898. No. 23897 A.

Obelisks.

How Did the Egyptians Raise their Obelisks? (Comment les Égyptiens ont-ils Érigé leurs Obélisques?). Short illustrated abstract of an article on this subject in *Construction Moderne* by J. C. Kruseman. 700 w. Le Génie Civil—Oct. 29, 1898. No. 24160 D.

Parthenon.

The Parthenon Marbles. Abstracts of a course of lectures given in the Alexandra School, Dublin, by Miss J. E. Harrison. Reviews the modern history of these marbles, and studies the Ionic frieze, the marbles that decorated the pediments, &c. 4500 w. Arch, Lond—Nov. 11, 1898. Serial. 1st part. No. 24041 A.

Steel Specifications.

Specifications for Structural Steel. Suggestions for their improvement. 900 w. Eng Rec—Nov. 26, 1898. No. 24215.

Tenements.

The Housing of the Poor. Abstract of address by the Lord Mayor of Dublin, showing that the condition of the very poor is also of immense importance to all classes. 2000 w. San Rec—Oct. 28, 1898. No. 23817 A.

Varnishes.

Varnishes, &c., Used in Building Structures, by Wood Workers, &c. The treatment of the various kinds of wood, and the composition of the varnish to be used. 4500 w. Builder—Oct. 29, 1898. No. 23853 A.

Venetian Palaces.

Some Palaces on the Grand Canal. C. T. Mathews. Part first gives an illustrated historical account of the Doges' Palace. 2400 w. Am Arch—Nov. 5, 1898. Serial. 1st part. No. 23840.

Wood.

Some Peculiarities of Wood. B. E. Fernow. Read at the convention of the Am. Inst. of Arch'ts. Comments on the small amount of knowledge concerning the nature, characteristics and properties of wood, and the wastefulness in consequence. Discusses the advantages and disadvantages as a material, &c. 3400 w. Am Arch—Nov. 19, 1898. No. 24034.

CIVIL ENGINEERING.

BRIDGES.

Bridge Erection.

Bridge Erection by Projection. Describes the erection of a number of bridges in this manner. 1000 w. Eng Rec—Nov. 19, 1898. No. 24021.

Buckling.

The Buckling of the Trusses of the New York and Brooklyn Bridge. F. Collingwood. An illustrated account of the circumstances which caused the buckling of the lower chords of the trusses in July last, with editorial comment. 3000 w. R R Gaz—Nov. 18, 1898. No. 24006.

The Management of the Brooklyn Bridge. Review of article by F. Collingwood on the stresses in the Brooklyn Bridge and the buckling of chord members of the stiffening trusses. 1700 w. Eng Rec—Nov. 26, 1898. No. 24216.

Ship Canals.

See Economics and Industry, Commerce.

Elbe.

The New Railway Bridge over the Elbe at Lobositz. (Die Neue Eisenbahnbrücke über die Elbe bei Lobositz.) H. Rosche. With view of the completed bridge, and plan of railway connections. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 28, 1898. No. 24116 B.

Japanese Bridge.

A Japanese Bridge. Drawing and brief description of a quaint, strong and handsome wooden bridge at Iwakuni, Japan. 250 w. R R Gaz—Nov. 11, 1898. No. 23902.

Loads.

Some Experiments on Bridges under Moving Train-Loads. F. E. Turneaure. Description of a series of experiments on bridges of varying span and design, giving results of tests, with description of apparatus used, and a discussion of the points involved. Ill. Pro of Am Soc of Civ Engs—Nov, 1898. No. 24232 F.

Melan Arch.

Two Recent Melan Arch Bridges. Illustrates and describes two bridges erected on the private estate of Mr. Frederick W. Vanderbilt at Hyde-Park-on-the-Hudson. 800 w. Eng News—Nov. 10, 1898. No. 23882.

Stresses.

Fatigue Formulas in Bridge Specifications. Editorial review of new bridge specifications, recognizing the fatigue of metals, with full abstract of paper by H. B. Seaman. 4000 w. Eng Rec—Nov. 5, 1898. No. 23792.

Safe Working Stresses. R. H. Thurston. Discussion of Mr. Stone's paper read at the July meeting of A. S. C. E. Reviews the knowledge that has been gained by experience and experiments, and discusses many points bearing on this subject. 3700 w. Sib Jour of Engng—Nov., 1898. No. 23987 C.

Working Stresses for Railroad Bridges. Brief abstract of a paper on railroad bridge specifications, by H. B. Seaman, with editorial discussion. 2500 w. R R Gaz—Nov. 4, 1898. No. 23783.

Suspension.

Old and New Forms of the Suspension Bridge. Gustav Lindenthal. A well-illustrated history of the suspension bridge with descriptions of the most notable examples. The difficulties of construction and engineering problems solved in former bridges are discussed, and a full description of the proposed Hudson River bridge at New York is given. 4000 w. Engineering Magazine—Dec., 1898. No. 24284 B.

The Covington and Cincinnati Suspension Bridge. Illustrated description of the construction of the new cables. 2200 w. Eng Rec—Nov. 26, 1898. Serial. 1st part. No. 24217.

CANALS, RIVERS AND HARBORS.

Alaska.

Surveys of the Gateways to Alaska. An account of the work done in mapping the delta of the Yukon and other operations of the coast survey. 900 w. Science—Nov. 18, 1898. No. 24012.

Antwerp.

The Quay Wall at Antwerp. Illustrated description of a very heavy wall of concrete blocks each having a pneumatic foundation. 1000 w. Eng Rec—Nov. 26, 1898. No. 24218.

Bohemia.

The Status of the Canal Work on the Moldau and Elbe in Bohemia. (Ueber den Stand der Canalisierungsarbeiten an der Moldau und Elbe in Böhmen.) An official illustrated report upon these important river improvements which form a part of the great internal water-ways system now being developed in Germany. 3000 w. 3 plates. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1898. No. 24122 D.

Cableways.

Cableway at Lock and Dam No. 2. Mississippi River Improvement. R. D. Seymour. Illustrates and describes a cableway showing decided improvement in construction and manner of operation. Also discussion. 5000 w. Jour W Soc of Engs—Oct., 1898. No. 23915 D.

Canal Operation.

The Efficiency and Cost of Operation of Canals. (Leistungsähigkeit und Betriebskosten der Canäle.) J. Deutsch. A long discussion of the relative advantages of inclined planes and locks for canals, and containing much useful information concerning the operation of internal waterways. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 14, 1898. No. 24-113 B.

Canal Transportation.

The Passing of the Canal. Editorial on the reasons why river and canal transportation in the United States has been gradually abandoned, and why railways have superseded water routes. 2200 w. Eng News—Nov. 24, 1898. No. 24-203.

Dam.

An Unusual Small Masonry Dam. Irving Righter. Illustrated description of an arched dam of cut stone. 800 w. Eng Rec—Nov. 26, 1898. No. 24220.

The Dam at La Bourbonée. (Le Barrage de La Bourbonée.) Detailed description of a masonry dam of medium size, with an illustration and a plate of details. 1500 w. La Rev Tech —Oct. 25, 1898. No. 24167 D.

Dredges.

Dredges on the Mississippi. (Die Bagger auf dem Mississippi.) R. Wels. A very full review of the Government work upon the Mississippi, with many illustrations of suction and bucket dredges, based on various official and professional reports. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1898. No. 24104 D.

Mississippi.

Improvement of the Mississippi River Delta. Thomas L. Raymond. Briefly reviews methods tried in the past, and describes the jetty system, the only successful plan found. 4400 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23-980 C.

New York Canals.

Canal Work Well Done. Abstract of statement of George W. Aldridge, with editorial comment. 7000 w. Sea—Nov. 3, 1898. No. 23782.

The Reply of State Engineer Adams to the Canal Investigating Commission. Abstracts of replies of the State engineer and Supt. of Public Works, with editorial comment. 5500 w. Eng News—Nov. 3, 1898. No. 23773.

Steel Aqueduct.

Steel Canal Aqueduct at Briare, France. Information from paper of Mr. Mazoyer, in *Annales des Ponts et Chaussées*. Illustrated description of interesting features of this engineering work, built to connect the Loire and Briare canals across the river Loire, near the town of Briare, France. 600 w. Eng News—Nov. 3, 1898. No. 23774.

Surveying.

Hydrographic Surveying in Nicaragua. Francis W. Belknap. A description of the methods employed by the Walker Board on the east interoceanic canal investigation. 4000 w. Eng Rec —Nov. 19, 1898. No. 24019.

IRRIGATION.

Anicut.

Lower Coleroon Anicut. An account of the

proposed improvements and their cost. 1200 w. Ind Engng—Sept. 24, 1898. No. 23714 D.

Egypt.

Public Works in Egypt. Summary of report for 1897, of Sir W. E. Garstin, Under Secretary for Public Works, upon the Irrigation Dept. Briefly reports the increase in the chief crops, and gives information of drainage works and other improvements. 1600 w. Arch, Lond —Nov. 11, 1898. No. 24040 A.

Irrigation Works.

Kuan Hsien Irrigation Works. Description of one of the oldest irrigation works in the world taken from a report of a journey made by S. J. L. Litton to North Ssu-ch'uan. 1200 w. Engr, Lond—Oct. 21, 1898. No. 23724 A.

Cement.

German Tests of Cement. Replies from a German point of view, to the questions issued by the Am. Soc. of Civ. Engs. Translated from the *Baumaterialienkunde*. 2200 w. Arch, Lond—Oct. 28, 1898. No. 23854 A.

History of the Portland Cement Industry in the United States. Robert W. Lesley. A brief account of the development from its inception, showing that the industry owes much to the application of American methods and processes; discussing also the methods in use in the United States and in Europe. Discussion. 6500 w. Jour Fr Inst—Nov., 1898. No. 23826 D.

Influence of Sulphate of Lime on the Hardening and Adhesion of Cements. (Influence du Sulfate de Chaux Contenu dans les Ciments sur le Durcissement et la Tenue les Bétons et Mortiers.) An abstract and review of recent work of M. Vialler on this subject. 1900 w. Le Génie Civil—Nov. 5, 1898. No. 24164 D.

Notes on Hydraulic Cement. A. W. Hale. Report of experiments to determine the percolation. 1400 w. Eng & Min Jour—Nov. 5, 1898. No. 23801.

Western Portland Cement Company's Plant, Yankton, S. D. Frederick H. Lewis. Illustrated description of works using chalk and clay and following the general scheme of English works on the Thames and Medway, with the exception of the methods of working the slurry. 1600 w. Eng Rec—Nov. 19, 1898. No. 24018.

Colorado.

Notes of an Engineer in Colorado. W. P. H. A letter containing information of interest about the railroads, mines, water-works, and other engineering works in the vicinity of Leadville. 4200 w. Eng News—Nov. 24, 1898. No. 24204.

Concrete Facing.

Concrete Facing on a Sandstone Bluff at St. Paul, Minn. Onward Bates. Describes the conditions and the reasons for using a concrete facing instead of cut-stone masonry, giving illustrated account of the work. 2000 w. Jour W Soc of Engs—Oct., 1898. No. 23916 D.

Contracts.

Extra Payments on Contracts. The opinion of the Utah Supreme Court on a contract requiring more work of certain classes than called for in the engineer's estimate. 1200 w. Eng Rec—Nov. 12, 1898. No. 23920.

Engineering Education.

Mr. W. H. Preece on Technical Education. Reply to an assertion by the President of the British Inst. of Civ. Engs., that professors in technical schools are arrogant and behind the age. 1200 w. Eng Rec—Nov. 19, 1898. No. 24016.

Forestry.

National Instruction in Forestry. A statement of the new method of the U. S. Agricultural Department to teach the management of woods and forests. 800 w. Eng Rec—Nov. 5, 1898. No. 23794.

Re-enforced Cement.

Re-enforced Cement Constructions. (Constructions en Ciment Armé.) Gérard Lavergne. A well illustrated general review of the subject of constructions in concrete with imbedded metals. The first part gives a general description of six systems. Serial. Part I. 1700 w. Le Génie Civil—Nov. 12, 1898. No. 24186 D.

Roads.

Road Building. An informal discussion by T. H. McCann, F. G. Cudworth, and M. D. Burke. 3300 w. Pro of Am Soc of Civ Engs —Nov., 1898. No. 24233 F.

Surveying.

A Trial at the Revision of the Survey System of France. (Un Essai de Réfection Intégrale du Cadastre.) Gérard Lavergne. A very full illustrated description of methods and instruments used in the survey of the commune of Neuilly-Plaisance, with reference to their application to a general resurvey of France. 3600 w. Le Génie Civil—Nov. 5, 1898. No. 24163 D.

Tunnelling.

Experience with Compressed Air Tunnelling. Abstract of a paper by George Henry Dunlop, read before the Victorian Inst. of Engs. at Melbourne, giving the writer's experience with hydraulic shield tunneling in connection with sewerage and other work, and referring to the relative advantages and disadvantages of each system. 4000 w. Engng—Nov. 11, 1898. No. 24070 A.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Agricultural Implements.

The Trade with Argentine in Agricultural Implements. Statistics of the exportation of iron and steel and manufactures of these products, showing that America supplies more than half the agricultural machinery, and discussing means of increasing the trade. 1200 w. Am Mfr & Ir Wld—Nov. 11, 1898. No. 23934.

American Coal.

American Coal in Foreign Countries. Articles from the *London Morning Leader*, and from the British *Coal and Iron Trades Review*, on the posssibilities of American coal competition. 1500 w. U. S. Cons Repts—Nov., 1898. No. 23811 D.

American Iron.

The American Iron and Steel Industries in 1897. Perry F. Nursey. A general review of the iron and steel trades as represented in the latest annual report of the Am. Ir. & St. Assn. 2500 w. Ind & Ir—Nov. 11, 1898. Serial. 1st part. No. 24051 A.

Brazil.

Resources of Brazil. An article on the economic condition of Brazil, written by L. Lipman, a well-informed local authority. Also a translation of the advertisement for coal for the Brazilian Central Railroad. 3300 w. U. S. Cons Repts—Nov., 1898. No. 23810 D.

British Trading.

British Trading Methods. Editorial on the charges brought against the British trader. 1700 w. Engng—Oct. 21, 1898. No. 23735 A.

China.

Chinese Railroad Development, Past, Present, and Future. Charles Denby and E. P. Allen. This interesting paper reviews the railway situation in China and gives the grounds for the popular objections to railway building in that country. Routes are described and the problem of conflicting claims by European nations discussed. It concludes with a review of present Chinese politics and describes the vast market for engineering products in the Orient. 4500 w. The Engineering Magazine—Dec., 1898. No. 24282 B.

New Conditions of Trade in China. Notes some of the changes taking place so rapidly in China, and their effect on trade. 1000 w. U. S. Cons Repts—Nov., 1898. No. 23815 D.

Trade of Amoy and Formosa. Editorial on the importance of looking after the interests of old ports as well as endeavoring to obtain a foothold in new ones, and giving particulars relating to the trade of the ports mentioned. 1300 w. Engng—Oct. 21, 1898. No. 23736 A.

Collection.

Southern Collection Laws. C. J. Haden. Showing that the collection laws of the Southern States do not meet the requirements of rapid commerce. Gives an analysis of their operation in relation to outside creditors. 2400 w. Mfrs Rec—Nov. 4, 1898. No. 23761.

Competition.

American Competition. Editorial on the annual report of the Am. Ir. & St. Assn. 2000 w. Engng—Nov. 11, 1898. No. 24069 A.

Egypt.

The Commercial Development of Egypt. Editorial directing attention to points connected with the recent industrial and commercial development, based mainly on a report by the U. S. agent and consul-general at Cairo. 1800 w. Engng—Nov. 11, 1898. No. 24068 A.

Exports.

Immense Export Trade Totals. Calls attention to features in the report for October which deserve notice; the value was the heaviest ever reported for that month, and second only to the total for Dec., 1897. 800 w. Bradstreet's—Nov. 19, 1898. No. 24025.

Free Trade.

England's Future Policy. A discussion of the free trade doctrine and the state of affairs that has been gradually developing during the last fifteen years. 3000 w. Gunton's Mag—Nov., 1898. No. 23806 C.

Greece.

United States Trade with Greece. A valuable report from the consular agent at Piraeus, in view of the movement to secure a direct line of steamships from the United States to the eastern Mediterranean ports. 1500 w. U. S. Cons Repts—Nov., 1898. No. 23812 D.

Interstate Commerce.

The Powers of the Interstate Commerce Commission. Charles A. Prouty. Discusses proposed legislation and the attitude of prominent railroad men, stating what the commission has asked in respect to rates. 6800 w. N Am Rev—Nov., 1898. No. 23776 D.

Iron and Steel.

United States Trade in Iron and Steel with the Netherlands. Report of the trade based on Dutch statistics. 1600 w. Am Mfr & Ir Wld—Nov. 25, 1898. No. 24264.

Mineral Traffic.

Mineral Traffic on Railways in 1897. Report for the United Kingdom, showing the progress as compared with 1896. 800 w. Col Guard—Nov. 18, 1898. No. 24278 A.

Ship Canals.

Equipment, Management, and Economic Influence of the Ship Canal. W. Henry Hunter. Takes the ground that engineering is applied economics, and discusses the subject from this broad standpoint. It describes the necessary terminal docks, railway connections, wharves, cranes and tackles, storage docks and warehouses, and extols the benefit to be derived from the construction of these waterways. Serial. 1st part. 4000 w. Engineering Magazine—Dec., 1898. No. 24283 B.

Shipping.

Shipping Rings. Editorial on facts brought out in the paper by John R. Galloway, read in the Economic Science section at the Bristol meeting of the British Assn. Discussing the bad effect of shipping rings on British commerce, and the remedy. 2500 w. Engng—Nov. 11, 1898. No. 24067 A.

Syndicates.

The French Rubber Syndical Chamber. E. Chapel. An explanation of the "Syndicats Professionnels" which have become of considerable importance in France. 1300 w. Ind Rub Wld—Nov. 1, 1898. No. 23762 D.

Timber.

The Timber Wealth of Pacific North America.

Frank Haines Lamb. Describes varieties of timber, quality of woods, output of mills and capacity of forests, shipments from various points and the evolution of the immense timber industry of the Pacific Coast. 4000 w. Engineering Magazine—Dec., 1898. No. 24290 B.

U. S. Trade.

United States Trade with Latin America. The latest statement showing the exports and imports. 2700 w. Bul of Bureau of Am Reps—Oct., 1898. No. 23847 C.

Yokohama.

Trade of Yokohama in 1897. Editorial discussion of the general increase of British trade, based on figures compiled by the British Acting Consul General from revised customs returns. 2000 w. Engng—Nov. 18, 1898. No. 24275 A.

CURRENCY AND FINANCE.

Chile.

Financial Conditions in Chile. An interesting review of the history of the situation, showing the causes leading to the failure of the resumption act of 1895, and some of the immediate effects of the law of 1898. 5000 w. U. S. Cons Repts—Nov., 1898. No. 23809 D.

Financial Position of Chile. A letter from Señor Don Eliodoro Infante, dated Aug. 24, 1898, addressed to the Sec. of the Nat. Sound Money League at Chicago. States the conditions affecting the currency problem. 1500 w. Bul of Bureau of Am Reps—Nov., 1898. No. 24267 C.

Finance.

Industrial Finance. An English editorial discussing the risks and advantages of the systems for raising money for use in manufacturing and trading concerns. 2800 w. Engng—Oct. 21, 1898. No. 23731 A.

India.

The Indian Exchange Banks and the Currency Puzzle. An article on the finance of trade. 3500 w. Bankers' Mag, Lond—Nov., 1898. No. 23848 C.

GOVERNMENTAL CONTROL.

Public Works.

Municipal Control of Public Works. H. J. Malochee. A discussion of the various plans adopted and suggested, and of the reasons for and against municipal control. 4500 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23981 C.

LABOR.

Compensation Act.

The Working of the Compensation Act at Yorkshire Collieries. James Lindsay. Read at meeting of the Yorkshire Branch of the National Assn. of Colliery Managers. Thinks that four months' experience shows that it affects employers most seriously and unjustly, and is not a blessing to the employed. Gives instances in the district named. 2300 w. Ir & Coal Trds Rev—Nov. 11, 1898. No. 24060 A.

Hours of Labor.

Eight Hours and the Constitution. On the need of establishing uniform hours of labor throughout the whole country. 3500 w. Gunton's Mag—Nov., 1898. No. 23808 C.

Management.

The Management of Men. Editorial on the address of Sir Benjamin C. Browne to the North-East Inst. of Engs. and Shipbuilders. 1800 w. Engng—Oct. 21, 1898. No. 23733 A.

Strikes.

Strikes and Lockouts in 1897. Statistics from the latest annual report of the British Board of Trade, with comments. 1600 w. Col Guard—Nov. 11, 1898. No. 24054 A.

Trade Disputes.

Conciliation and Arbitration in Trade Disputes. From an article by Sir Edward Fry in the Nov. issue of the *Law Magazine and Review*. Considers the Conciliation Act now in force in England. 1200 w. Col Guard—Nov. 4, 1898. No. 23941 A.

MISCELLANY.

Coal Industry.

The Coal Industry as an Index of National Progress. A method of testing the industrial life of the nation in comparison with other countries, based on the use of coal for power purposes. 2300 w. Col Guard—Oct. 28, 1898. Serial. 1st part. No. 23865 A.

Disarmament.

The Tsar's Eirenicon. E. J. Dillon. A discussion of the Tsar's proposal, the diplomatic action about to be taken, the difficulties, and various phases of the problem. 15,300 w. Contemporary Rev—Nov., 1898. No. 23955 D.

Far East.

The Far Eastern Crisis. Archibald R. Colquhoun. A discussion of this question, which has become of importance to all the world, and of the Burlingame policy which has been followed by Engand and the United States, showing its effect in relation to the present situation, 6000 w. N Am Rev—Nov., 1898. No. 23775 D.

Fibre Industries.

The Possible Fibre Industries of the United States. Charles Richards Dodge. Shows the importance of these industries as new sources of national prosperity, outlining the difficulties of the problem and the points of vantage. Ill. 5500 w. Ap Pop Sci M—Nov., 1898. No. 23720 D.

Junior Republic.

A Novel Educational Experiment. Charles Burr Todd. An account of this interesting work among the poor children, and its latest developments. 4000 w. Gunton's Mag—Nov., 1898. No. 23807 C.

Rhea Fibre.

The Preparation of Rhea Fibre for Textile Purposes. Perry F. Nursey. Read before the Society of Engineers. The experiences of the writer with this product, supplemented by the work of others. 4500 w. Ind & Ir—Nov. 11, 1898. Serial. 1st part. No. 24052 A.

Sulphuric Acid.

Sulphuric Acid and the By-Products from Iron Pyrites. R. G. Ewer. Reviews the early history the various improvements, and present mode of manufacture. 4800 w. Jour Assn of Engng Soc's—Oct., 1898. No. 23982 C.

Tropical Development.

European Experience with Tropical Colonies. W. Alleyne Ireland. Reviews the experience of France, Holland and Great Britain, and gives the opinion that when the population is composed entirely of negroes, success requires a system of forced labor. 4600 w. Atlantic M—Dec., 1898. No. 24230 D.

Our Government of Newly Acquired Territory. Carl Evans Boyd. Reviews the extensions of the United States in the past and the territorial governments established, and discusses the differences which must influence governmental policy in dealing with recently acquired possessions. 4500 w. Atlantic M—Dec., 1898. No. 24231 D.

The United States and the Control of the Tropics. Benjamin Kidd. Discusses whether the United States can safely enter upon a policy of expansion. The article is called out by queries in a letter from the editor. 4300 w. Atlantic M—Dec., 1898. No. 24229 D.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Ancient Telegraphy.

Ancient Methods of Telegraphy. Lawrence Irwell. Describes the kinds of telegraphy used before the invention of the electrical apparatus. 2200 w. Elec Engng—Nov., 1898. No. 24033.

Electric Bells.

Electrical Alarums. J. Ebel. A general illustrated description of recent improvements. 1500 w. Elec Rev, Lond—Oct. 28, 1898. No. 23858 A.

Electrical Plant.

Electrical Plant, Indo-European Telegraphs, Karachi. Some particulars in regard to the electrical plant sent to light these offices, with the object of giving a cooler and better light to the signallers. 1300 w. Ind Engng—Oct. 8, 1898. No. 23899 D.

Exchange.

New Telephone Exchange at Newport, R. I. An illustrated description of the new building and its equipment. 700 w. Elec Eng, N. Y.—Nov. 10, 1898. No. 23824.

French Cable.

The New French Atlantic Cable. An account of the construction and laying of this cable which connects Brest with Cape Cod. It is the longest submarine cable in existence, and is remarkable in having a heavier core than any other section. 1000 w. Elec Eng, N. Y.—Nov. 10, 1898. No. 23823.

Grapnels.

Submarine Cable Grapnels. Charles Bright. A statement of the requirements, with illustrated description of grapnel apparatus. 2000 w. Engng—Nov. 4, 1898. Serial. 1st part. No. 23935 A.

Space Communication.

Tesla's Latest Invention. Text of a recent patent describing an invention for controlling the operations of a mechanism without any tangible connection and from a great distance. Also editorial. 1000 w. Elec Rev, N. Y.—Nov. 9, and 16, 1898. Serial. 2 parts. No. 23875.

Transmission of Power Through the Air Without Wires. John Trowbridge. Reports some experiments of the writer, interesting in connection with Mr. Tesla's recent patent of a method of transmitting power through the air without wires. 800 w. Sci Am—Nov. 19, 1898. No. 23975.

Submarine Cables.

The Extension of Submarine Telegraphy in a Quarter Century. Charles Bright. A very interesting description of the extension of submarine cables since the early days. Illustrated with a large map of the world showing all cable routes. Historical notes of interest concerning numerous cable projects. The capital invested to-day in cables is larger than that in any other branch of electrical industry, amounting to £55,000,000 sterling. 4000 w. Engineering Magazine—Dec., 1898. No. 24288 B.

The Development and Present Status of Submarine Telegraphy and Cables. Herbert Laws Webb. Based upon "Submarine Telegraphs," by Charles Bright. A review of this book with favorable comment. 6500 w. Elec Eng, N. Y.—Nov. 10, 1898. No. 23822.

Switchboard.

Multiple Telephone Switchboard (Commutateur Multiple Téléphonique). Dubreuil. General illustrated description of the principle of the multiple exchange switchboard. 1200 w. L'Electricien—Nov. 7 and 12, 1898. No. 24166 each B.

The Novel Switchboard at the Harlem Exchange of the New York Telephone Company. Describes a new switchboard in which the miniature incandescent lamp signals so distinctly that the operators work is reduced to the simplest operations. 1000 w. Elec Eng, N. Y.—Nov. 24, 1898. No. 24081.

Telephone Signal.

Evolution of the Telephone Signal. H. P. Clausen. Gives the history of signalling apparatus as used in telephone work. Ill. 2500 w. W Elect'n—Nov. 19, 1898. No. 24074.

DISTRIBUTION.

Converters.

Rotary Converters. Silvanus P. Thompson. Read before the Inst. of Elec Engs., England. Describes a rotary converter and considers the

machines devoted to the purpose of converting continuous currents into alternating currents of of one, two, or three phases, or *vice versa*. 3300 w. Elec Eng, Lond—Nov. 11, 1898. Serial. 1st part. No. 24050 A.

ELECTRO-CHEMISTRY.

Cadmium.

Some Notes on the Electro-Deposition of Cadmium and Its Alloys. Sherard Cowper-Coles. Explains why cadmium is used for the manufacture of fusible wires for electric cut-outs, and gives information concerning the deposition and the various alloys. 3500 w. Elec Rev, Lond—Oct. 21, 1898. No. 23719 A.

Copper Refining.

The Electro-Deposition of Copper. Reviews the history and progress of this electro-chemical industry, briefly describing the Elmore process and the Demoulin process. 1700 w. Engng—Oct. 21, 1898. No. 23734 A.

Metallurgy.

The Electrolytic Winning of Metals Direct from the Ore. (Ueber Elektrolytische Reingewinnung von Metallen Direkt aus Ihren Erzen.) Dr. C. Hoepfner. A description of the author's process of separating copper by the use of chloride of copper as a solvent for the ore, followed by electrolytic reduction. 3000 w. Elektrotech Zeitschr—Nov. 3, 1898. No. 24141 B.

ELECTRO-PHYSICS.

Alternate Currents.

Notes on Alternate Current Calculations. The first of a series of articles on the arithmetic of alternate current distribution, including arithmetical examples relating to polyphase currents. 900 w. Elec, Lond—Oct. 28, 1898. Serial. 1st part. No. 23857 A.

Magnetism.

Magnetic Researches. (Magnetische Untersuchungen.) Dr. Erich Schmidt. A general review of the fundamental notions of magnetism and magnetic phenomena, with explanations and definitions especially intended to inform the general engineer. Serial, Part 1. 4000 w. Zeitschr f Elektrochemie—Nov. 3, 1898. No. 24142 G.

Sheet Iron.

Investigations of Sheet Iron. (Untersuchungen von Eisenblechen.) W. Röhr. A detailed account of experimental tests of the magnetic properties of sheet-iron plates, with tables of data and results. The experiments were made both with direct and alternating currents. 3000 w. Electrotech Zeitschr—Oct. 27, 1898. No. 24138 B.

Radiography.

The Progress of the Technique of Röntgen Rays. (Die Fortschritte der Roentgentechnik). A general review of the advance which has been made in the technique of radiography since the original discovery of Prof Röntgen. 3000 w. Schweizerische Bauzeitung—Nov. 5, 1898. No. 24130 B.

X-Rays in the Army. H. Lyman Sayen. The arrangements for x-ray work at Fort McPherson, Ga., and the success in diagnostic work. 1700 w. Elec Wld—Nov. 5, 1898. No. 23804.

GENERATING STATIONS.

Alternator.

Compounding Alternators for Constant Voltage. (Sur le Compoundage des Alternateurs à Voltage Constant). Maurice Leblanc. Illustrated description of an ingenious auxiliary exciting method which is applicable to alternators having high armature reactance, permitting them to be paralleled, etc. 1200 w. Comptes Rendus—Nov. 7, 1898. No. 24187 D.

Belfast, Ireland.

The Belfast Electricity Works. History of the undertaking with illustrated description of these new works. 4000 w. Elec Eng, Lond—Oct. 21, 1898. No. 23711 A.

Boston, Mass.

Ths Boston Electric Light Company's New Station. Illustrated description of a 9000 kilowatt plant generating three-phase current for public and private lighting service. The building measures 244x174 ft. and contains unusual structural and mechanical features. 2600 w. Eng Rec—Nov. 19, 1898. No. 24023.

The New Generating Station of the Boston Electric Light Company. Illustrates and describes a system in course of construction with the view of bringing an old installation up to date. 3000 w. Elec Wld—Nov. 19, 1898. No. 23969.

The New Station of the Boston Electric Light Company. Illustrates and describes the new plant, located in South Boston, from which current is distributed by the three phase system. 2500 w. Elec Eng, N. Y.—Nov. 24, 1898. No. 24079.

Commutators.

Notes on Commutator Design. F. J. A. Matthews. Considers faults in construction, bad connections, and the using too small a commutator. 2300 w. Elec Rev, Lond—Oct. 21, 1898. No. 23718 A.

Dynamo Calculations.

Short Cuts in Dynamo Calculations. Cecil P. Poole. Gives analysis of method, the object of which was economy in time, now modified so as to make it applicable to standard practice in designing. 1500 w. Elc Wld—Nov. 26, 1898. No. 24093.

Dynamo Test.

Test of a Multi-Circuit Direct-Current Dynamo. Edward J. Murphy, Jr., and P. Edwin Van Saun. Describes a test of the Rushmore dynamo. Ill. 2200 w. Am Elect'n—Nov., 1898. No. 23740.

Florence.

The Central Station of the Società Toscana in Florence. (La Stazione Centrale della Società Toscana in Firenze.) Alberto Picchi. Short description of an important new Italian railway, lighting and power distribution station. Accumulators and a 3-wire 300 volt system are used. 1100 w. Rivista Gen delle Ferrovie—Nov. 6, 1898. No. 24194 B.

Folkestone.

The Folkestone Electricity Supply Works. Illustrated detailed description of electric-lighting plant. 2400 w. Elect'n, Lond—Nov. 11, 1898. No. 24039 A.

Hull, England.

Hull New Central Station. Brief history of the work at this place since 1889, with an illustrated description of the new works. 1400 w. Elec Eng, Lond—Oct. 28, 1898. No. 23855 A.

Isolated Plant.

Lighting Plant of the Empire Building, New York City. Illustrated description of a 350 k. w. plant in a 21-story building. 1400 w. Eng Rec—Nov. 26, 1898. No. 24226.

Llandudno, Wales.

Llandudno Municipal Electric Supply Works. Illustrates and describes a system of electrical supply for a North Wales watering place. 2200 w. Elect'n, Lond—Oct. 28, 1898. No. 23-856 A.

Nuremberg.

The Electric Plant of the City of Nuremberg. (Das Städtische Elektricitätswerk Nürnberg.) Philipp Scholtes. A very complete and fully illustrated account of this important station, in which current is generated and distributed for lighting and power. Valuable data as to costs are given. Two articles. 12000 w. Electrotech Zeitschr—Nov. 3, 10, 1898. No. 24139 each B.

Polyphase Practice.

Polyphase Practice in Small Stations at the Plant of the Hackensack Gas and Electric Company. A description, with illustrations, of the equipment and service of the plant of the Hackensack Gas and Electric Co. 2200 w. Am Elect'n—Nov., 1898. No. 23738.

Power Plant.

Power Plant of the Washington Mills Company, Lawrence, Mass., U. S. A. Explains the need of increasing the power, and gives illustrated description of the specially designed boilers, and report of the engine trials. 3500 w. Engng—Oct. 21, 1898. No. 23737 A.

Power Station.

The Mammoth Central Power Station of the Metropolitan Street Railway Company, New York. Brief illustrated description of a power house of a 70,000 h. p. capacity, designed to supply power to all the electric lines of this company. 1500 w. Sci Am—Nov. 12, 1898. No. 23890.

Sarajevo, Bosnia.

The Electric Station at Sarajevo. (Das Elektricitätswerk in Sarajevo.) Ludwig Spängler. An illustrated account of this important hydraulic power electric station, and description of the applications of current for lighting and tramways. 7500 w. 2 plates. Zeitschr d' Oesterr Ing u Arch Ver—Oct. 21, 1898. No. 24114 B.

Small Plants.

Economies in Small Electric Light Plants. E. P. Roberts. Read before the Ohio Elec. Assn. Discusses how to operate a small plant economically. 5000 w. W Elect'n—Nov. 19, 1898. No. 24073.

Washington, D. C.

The United States Electric Lighting Company of Washington, D. C., and Its New Electrical Equipment. Nevil Monroe Hopkins. Gives briefly the history of the company, with illustrated description of its fine new central station and its equipment. 4500 w. Elec Eng, N. Y. Nov. 3, 1898. No. 23766.

HEATING AND WELDING.

Warming.

Electric Heating. (Elektrische Heizung.) An address by Dr. Voit before the German Society of Heating and Ventilating Engineers, giving data and methods for the proportioning and application of electric apparatus for warming; with discussion showing the cost of the method. 3000 w. Gesundheits Ingenieur—Oct. 15, 1898. No. 24126 B.

LIGHTING.

Arc Lamps.

Improvements in the Arc Lamp. Robert A. Ross. Reviews the history of the arc lamp from its commercial beginning in 1879, the various types of lamps, and the present practice. 2600 w. Can Elec News—Nov., 1898. No. 23932.

The Illumination of Manufacturing and Business Establishments by the Arc Light. (Fabrik und Bureaubeleuchtung durch Bogenlicht.) A discussion as to the best method of suspending, distributing and reinforcing arc lamps in the illumination of workshops, &c. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 5, 1898. No. 24112 D.

Decorative Effects.

Electricity in the Schilling Gardens. R. W. Lohmann. Illustrates and describes the private grounds of A. Schilling, in Oakland, Cal., with special reference to the electrical features. 2800 w. Jour of Elec—Oct., 1898. No. 23962.

Electric Lighting as Applied to Architecture. Thomas Ekin. Read at meeting of the Archt. Assn. Discusses the use of the incandescent electric lamp and urges the consideration of each room separately with a view to the purpose for which it is to be used, general surroundings, &c. Also considers the wiring. 2200 w. Elec, Lond—Nov. 16, 1898. No. 23968.

MEASUREMENT.

Phasemeter.

Dobrowolski's Phasemeter. (Phasemètre de von Dolivo Dobrowolski). M. Aliamet and E. J. Brunswick. Illustrated description of a simple and ingenious instrument which gives direct readings of phase displacement. 800 w. L'Electricien—Oct. 29, 1898. No. 24165 B.

Wright Meter.

The Wright Discount Meter and Its Use in Central Station Management. Illustrated de-

tailed description of what is claimed to be a very useful instrument. 2000 w. Elec Eng. N. Y. —Nov. 24, 1898. No. 24080.

POWER APPLICATION.

Diagrams.

A Practical Method of Determining the Diagrams of Polyphase Motors. (Praktische Vorausbestimmung der Drehstrommotoren.) A. Rothert. A geometric method of calculating the complete diagram in advance of the construction of the motor. 2000 w. Elektrotech Zeitschr—Nov. 3, 1898. No 24140 B.

Drill.

A German Electric Drill. W. Meissner. Illustrates and describes features of a machine which is soon to be put in operation in Colorado. 1500 w. Mod Mach—Nov., 1898. No. 23831.

Electric Locomotive.

See Street and Electric Tramways.

Electrical Machinery.

Some French Electrical Machinery. Illustrates and describes products manufactured by Fabius Henrion, Nancy, France, showing how they differ from American designs. 3000 w. Elec Wld—Nov. 19, 1898. No. 23970.

Electric Printing.

The Electrical Equipment of a Model Printing Establishment. George A. Damon. Slightly abstracted reprint of a paper read before the Chicago Elec. Assn., describing and illustrating the model printing establishment of the W. B. Conkey Co., at Hammond, Ind. 4800 w. Elec Wld—Nov. 12, 1898. No. 23898.

Electric Pumps.

The Application of Electric Power to Pumping Machinery. S. H. Bunnell. A fully illustrated description of all the modern forms of electrically operated pumps, for mining and other purposes. Shows the opportunity for further development of electric pumps. 3000 w. Engineering Magazine—Dec., 1898. No. 24289 B.

Elevators.

The Electric Elevator Equipment for the Central London Underground Ry. An illustrated description of an interesting electric elevator equipment being installed by the Sprague Electric Co., of New York city. 6000 w. Eng News—Nov. 3, 1898. No. 23770.

TRANSMISSION.

High Voltage.

High-Voltage Power Transmission. Charles F. Scott. Describes important work in this field, giving the methods by which measurements have been made and the results which have been reached, and a number of points of interest regarding long distance transmission plants. 12500 w. Trans Am Inst of Elec Engs—Oct., 1898. No. 24078 D.

Insulation.

Apparatus for Direct Indication of Loss of Current. (Isolationskontrollsystem zur Direkten Anzeige Stromentweichungen.) Dr. M. Kallman. A description of a special form of ampere meter by means of which imperfections in the insulation of a distributing system may be detected. Two articles. 7000 w. Elektrotech Zeitschr—Oct. 13, 20, 1898. No. 24136 each B.

Lightning Arresters.

Types of American Lightning Arresters. Henry E. Raymond. Illustrates and describes many types, showing the great dissimilarity in the application of similar principles. 2200 w. Am Elect'n—Nov., 1898. No. 23741.

Mine Transmission.

Electrical Transmission of Power in Mining. W. B. Esson. Abstract of paper read at meeting of Inst. of Civ. Engs. (England). Describes the plant erected at the Sheba Gold Mining Company's Mine. 1100 w. Col Guard—Nov. 18, 1898. No. 24279 A.

Switzerland.

The Transmission Plant Les Clees Yverdon. J. Laffargue, in *L'Industrie Electrique*. Translated description with comments from an American point of view. Ill. 1500 w. Elec Wld—Nov. 26, 1898. No. 24092.

MISCELLANY.

Address.

Applications of Electricity. W. H. Preece. Abridged from an inaugural address delivered at the Inst. of Civ. Engs. (England). Shows the enormous strides made in the use of electricity, touching on special applications in various fields. 3800 w. Nature—Nov. 3, 1898. No. 23959 A.

Electro-Therapeutics.

High Frequency Oscillators for Electro-Therapeutic and other purposes. Nikola Tesla. Read at meeting of American Electro-Therapeutic Assn., at Buffalo, N. Y. An account of the writer's experiments in this field, describing apparatus used. Ill. 7000 w. Elec Eng, N. Y.—Nov. 17, 1898. No. 23967.

Nomenclature.

A Nomenclature for the Characteristic Magnitudes for Alternating Currents. (Zur Benennung der Charakteristischen Grössen des Wechselstromkreises.) C. P. Feldmann. An attempt to derive a distinctly Teutonic nomenclature, to replace the terms derived from classical roots and used by all other scientific nations. 4000 w. Elektrotech Zeitschr—Oct. 20, 1898. No. 24137 B.

MARINE ENGINEERING.

Battleships.

See Military Engineering.

Bulkheads.

Test of the Bulkhead Separating the Engine Rooms of the Battleship "Illinois." J. J. Woodward. Abstract of a paper read at meeting of the Soc. of Naval Archts. and Marine Engs Describes the three tests made, giving results Ill. 3300 w. Eng News—Nov. 17, 1898. No 24002.

Test of the Strength of a Longitudinal Bulkhead Separating two Engine Rooms. J. J. Woodward. With description of the bulkhead construction on the U. S. S. Kearsarge, Kentucky, and Illinois, and an account of the tests. 4500 w. 4 plates. Trans Soc N A & M E—1898. No. 24257 F.

Cruiser.

See Military Engineering.

Derrick.

An Electrically Operated 150-Ton Revolving Derrick. Walter A. Post. A general description of the derrick at the yards of the Newport News Shipbuilding and Dry Dock Co., with numerous detail drawings. 4000 w. 10 plates. Trans Soc N A & M E—1898. No. 24258 F.

Feed Pump.

See Mechanical Engineering, Steam.

Gunboats.

See Military Engineering.

Launching.

Launching Mishaps. Gives a brief enumeration of representative examples, with remarks. 1700 w. Engr, Lond—Oct. 21, 1898. No. 23722 A.

Meteorology.

The Origin of Storms. (Sopra le Origini delle Tempeste.) G. Tolomei. A general dissertation on the various theories of the nature and origin of storms, illustrated with diagrams. 8000 w. Rivista Marittima—Aug.-Sept., 1898. No. 24191 H.

Mishaps.

Mishaps at Sea. An account of the loss of the Atlantic Transport Line steamship Mohegan, off the Lizard, England, and other vessels. Ill. 1000 w. Marine Engng—Nov., 1898. No. 23836 C.

Navigation.

Abacus for Calculating Latitudes from Meridian Altitudes. (Abbaco per il Calcolo della Latitudine Medianti un'Altezza Circummeridiana.) G. Pesci. Illustrated description of a simple and rapid method of finding latitudes at sea. 3500 w. Rivista Marittima—Oct., 1898. No. 24193 H.

Paddle-Wheels.

Paddle Wheels. A. E. Mills. Paper read before the Inst. of Marine Engs. Traces the development from the earliest form used, and analyzes their working. Ill. 2000 w. Mech Wld—Oct. 28, 1898. No. 23820 A.

Shipbuilding.

Methods of Securing Watertight Work. H. G. Smith. A discussion of the best methods of construction for bulkheads, double-bottoms, &c., in order that watertight work may be assured, with especial reference to the vessels of the U. S. Navy. 7500 w. 9 plates. Trans Soc N A & M E—1898. No. 24256 F.

The Steel Foundation of the Shipbuilding Industry. James Riley. A history of the use of steel in shipbuilding. The article describes fully the troubles encountered by the British Admiralty in the earlier attempts to build steel ships, the growth of the steel-making industry and the improvement and standardizing of the product. The machinery of the steel mill and its evolution are described. The recognition of the possibilities of steel by the marine engineer led to the greatest triumphs of his profession. 4500 w. Engineering Magazine—Dec., 1898. No. 24285 B.

Stability.

Bilge Keels and Rolling Experiments. Lawrence Spear. A description of the manner in which bilge keels were added to the U. S. S. Oregon, together with an account of the experimental demonstration of the effect in increasing stability. 4000 w. 4 plates. Trans Soc N A & M E—1898. No. 24251 F.

Stability of a Battle-ship Under Damaged Conditions. C. H. Peabody. A study of stability based upon experiments upon a model, with numerous diagrams. 2000 w. 3 plates. Trans Soc N A & M E—1898. No. 24259 F.

Steamship.

Steamship Kaiser Wilhelm der Grosse. (Le Paqueboat Kaiser Wilhelm der Grosse.) M. Hachebet. Illustrated description of the boilers and engines, refrigerating and electric lighting plants, with plate giving two plans and longitudinal section. 6000 w. Le Génie Civil—Oct. 15, 1898. No. 24150 D.

S. S. Winifred, the Pioneer American Steel Cargo Ocean Steamship. William A. Fairburn. Illustrated detailed description with dimensions and report of trials. 1700 w. Marine Engng—Nov., 1898. No. 23833 C.

Wave Propulsion.

A Wave Propelled Boat. Illustrates and describes a device attached to boats for producing motion, invented by H. F. L. Linden. 1100 w. Sci Am—Nov. 12, 1898. No. 23894.

Yachts.

See Military Engineering.

MECHANICAL ENGINEERING.

AUTOMOBILISM.

Battery Handling.

The Electric Vehicle Company's Battery Handling Machinery. Hugh Dolnar. Describes and illustrates devices invented by G. Herbert Condit, for handling and charging storage batteries on a large scale. 3000 w. Am Mach—Nov. 10, 1898. No. 23901.

Design.

A Design for an Electric Automobile Vehicle. Charles T. Child. Working drawings and description of a type of motor vehicle that can be constructed by an amateur of ordinary mechanical skill, and at comparatively small cost. 5000 w. Sci Am Sup—Nov. 26, 1898. No. 24085.

Heavy Weights.

Electric Automobiles at the Paris Concourse. Compiled and translated from the French technical journals. The first of a series of articles describing the vehicles and their performance. Ill. 6000 w. Elec Wld—Nov. 5, 1898. Serial. 1st part. No. 23805.

Heavy Motor-Car Trials in France. An account of the trials with illustrations of the vehicles. 3200 w. Engr, Lond—Oct. 28, 1898. No. 23872 A.

Second Concourse of Heavy Weights. (Deuxième Concours des Poids Lourds.) Ch. Talausier. Short description of the concourse with table of data of competing vehicles. 2400 w. Le Génie Civil—Oct. 15, 1898. No. 24152 D.

The Heavy Motor Car Trials in France. Discusses the recent trials and what they have proved. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23945 A.

Law.

The French Law Relating to Automobilism. A free translation of the new law lately passed by the States Council. 2200 w. Automotor Jour—Oct. 15, 1898. No. 23717 A.

Motor Vehicles.

Some Sanitary and Allied Advantages Attending the Introduction and Use of Moto-Vehicles. E. Schrapnell Smith. Excerpt from a paper read before the Sanitary Inst. of Birmingham, Eng. The advantages claimed are considered under the divisions of improvement in sanitary conditions, and reduction in public expenditure. 2700 w. Automotor Jour—Oct. 15, 1898. No. 23716 A.

Trials.

The Royal Agricultural Society's Trials of Moto-Vehicles. The judge's report, description of vehicles, summary of times and speeds, consumption of fuel and cost of running, with conclusions. 5000 w. Automotor Jour—Oct. 15, 1898. No. 23715 A.

HYDRAULIC ENGINEERING.

Hydraulics.

The New Hydraulics: An Essay for Advanced Students in the Art, and for Those who Look Beneath the Surface Clemens Herschel. Reviews important experiments, and urges the collection of new coefficients derived from experiment. 1300 w. Eng News—Nov. 10, 1898. No. 23883.

Flow.

Formulæ for the Flow of Water in Open Channels. (Formeln zur Berechung des Wasserabflusses in Offenen Gerinnen.) R. Siedek. A comparison of the measurements made on the Danube at Vienna with the computed flow by the formulas of Bazin and of Kutter. 1200 w. Oesterr Monatschr f d Oeffent Baudienst—Nov., 1898. No. 24124 D.

MACHINE WORKS AND FOUNDRIES.

Boring Machine.

Horizontal Boring and Milling Machine. (Horizontal- Bohr- und Fräsmaschine.) Brief illustrated description of a powerful machine-tool, with plate giving working elevation drawing. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 22, 1898. No. 24103 D.

Casting.

Casting a Corliss Cylinder. R. H. Palmer. Illustrates and describes the manner of casting as approved by William H. Harris, builder of the Harris-Corliss engine. He considers this type of cylinder is more satisfactory cast horizontally and with the valve seats vertical. 2000 w. Am Mach—Nov. 24, 1898. No. 24096.

Casting a Locomotive Cylinder. W. T. Mohan. A description of present practice. 1200 w. Sib Jour of Engng—Nov., 1898. No. 23989 C.

Cast Iron.

Cast Iron. Dr. Richard Moldenke. Read before the Engs. Soc. of W. Penna, at Pittsburg. Considers the materials, processes of melting, constitution, micro-structure, segregation and shrinkage, tests, &c. 4000 w. Ir Trd Rev—Nov. 17, 1898. No. 23990.

Cost-Keeping.

A Simple and Effective System of Shop Cost-Keeping. H. M. Norris. Describes fully a simple and effective system of gauging the cost of work in process of manufacture, with many blank forms found useful in experience. A practical and valuable article. 4500 w. Engineering Magazine—Dec., 1898. No. 24286 B.

Drill.

A Large Radial Drill. (Grosse Radialbohrmaschine.) Description, with photograph, and working plan and elevation of a large radial drill press adapted either for belt or electric driving. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 5, 1898. No. 24111 D.

See also Electrical Engineering, Power Application.

Engine Works.

Lincoln Engine Works, Chesterfield. Illustrates and describes a well thought out plan of engineering works, giving details of construction of the building and the general design. 2800 w. Engng—Nov. 11, 1898. Serial. 1st part. No. 24066 A.

Floors.

Best Floors for Shops and Round Houses. Extracted from a committee report presented at the convention of Assn. of Ry. Supts. of Bridges and Buildings. Ill. 2300 w. Ry & Engng Rev—Oct. 22, 1898. No. 23800.

Fly-Wheels.

The Bursting of Small Cast-Iron Fly-Wheels. Charles H. Benjamin. Describes a series of experiments on small cast-iron wheels, at the Case School of Applied Science, for the purpose of investigating the causes of failure. Ill. 2800 w. Trans of Am Soc of Mech Engs, No. 795—Nov., 1898. No. 24237 D.

Lathes.

A Special Lathe for Threading Taps. Illustrates and describes a special tool made for a tap and die factory, to cut threads upon the taps. 800 w. Am Mach—Nov. 17, 1898. No. 23971.

Lathe Attachment for Turning Cast Wrist Pins. C. P. Benns. Illustrates and describes the arrangement and its operation. 1500 w. Am Mach—Nov. 3, 1898. No. 23791.

Locomotive Boiler.

How to Lay Out a Locomotive Boiler. Henry J. Raps. Method of laying out a taper course or the frustum of a right cone and its application to the laying out of an elbow. 1200 w. Loc Engng—Nov., 1898. No. 23778 C.

Machine.

What is a Machine? (Was ist eine Maschine.) P. K. V. Englemeyer. A discussion of the meaning and scope of the word "machine" from the kinematic standpoint, giving the critical definitions of various authorities. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 22, 1898. No. 24106 D.

Molding.

Ethics of Bench Molding. Henry Hansen. Some remarks on small castings, the causes of their not being true to pattern, &c. 2500 w. Am Mach—Nov. 17, 1898. No. 23972.

Riveting.

Portable Pneumatic Riveters. Describes results obtained in a large shipyard. 800 w. Eng Rec—Nov. 19, 1898. No. 24020.

Portable Pneumatic Riveters in Shipbuilding. W. I. Babcock. A discussion of the advantages of power riveting in general, and of the especial applicability of pneumatic riveting to shipbuilding. 3000 w. 12 plates. Trans Soc N A & M E—1898. No. 24253 F.

Screw-Threads.

The Present Status of a Standard Metric Screw Thread System. (Referat über den Gegenwärtigen Stand der Frage Betreffend die Einführung eines Metrischen Gewindesystems.) A discussion, by the German Railway Society, of the metric screw-thread system proposed by the international commission at Berne. 3500 w. Glaser's Annalen—Nov. 1, 1898. No. 24121 D.

Zurich International Congress for Standardizing Threads. (Congrès International pour l'Unification des Filetages à Zurich.) Ed. Sauvage. Short account of the more important conclusions reached by the congress. The system is practically that of the French Société d'Encouragement. 900 w. Bulletin de la Société d'Encour—Oct., 1898. No. 24173 G.

Seamless Tubing.

The McCool Seamless Tubing. An illustrated account of the manufacture of seamless steel tubing by a new process of rolling. 1200 w. Am Mfr & Ir Wld—Nov. 11, 1898. No. 23933.

Springs.

The Computation of Springs for Valves of Engines and Compressors. (Berechnung der Federn für die Ventile von Dampfmaschinen und Kompressoren.) W. Trinks. A very thorough discussion of the proportioning of springs for the correct closing of valves, with numerous practical examples. 4500 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1898. No. 24102 D.

Tool Shop.

A Notable German Tool Shop. F. J. M. Illustrated description of the shops of J. E. Reinecker, Chemnitz, Germany, and the methods employed there. 2500 w. Am Mach—Nov. 3, 1898. No. 23790.

Tools.

Steam Engine Tools and Gages used by Struthers & Wells Iron Works. John Randol. Illustrates and describes the tools and fixtures used. 2000 w. Am Mach—Nov. 24, 1898. No. 24094.

Wheel Rims.

Note on Strength of Wheel Rims. Albert K. Mansfield. Calling attention to the fact that under some conditions ribbing does not have a strengthening effect. Ill. 700 w. Trans of Am Soc of Mech Engs, No. 794—Nov., 1898. No. 24236 D.

Worm Wheels.

Experiments with Wormwheel Driving. (Versuche mit Schneckenradgetrieben.) R. Stribeck. A record of quantitative tests of efficiencies of worm gear driving at various pressures and speeds; being a continuation of experiments published last year. A valuable paper. 3500 w. Zeitschr d Ver Deutscher Ing—Oct. 15, 1898. No. 24101 D.

MATERIALS OF CONSTRUCTION.

Ceramics.

Observations upon the Research upon Expansion of Pastes by M. Coupeau. (Observations Déduites de l'Etude sur les Dilatations Céramiques de M. Coupeau.) Georges Vogt. An addendum to Coupeau's paper containing further data. 2800 w. Bulletin de la Société d'Encouragement—Oct., 1898. No. 24175 G.

Research upon the Expansion of Ceramic Pastes. (Etude sur la Dilatation des Pates Céramiques.) M. Coupeau. A very elaborate illustrated paper containing a large number of tables of data, and giving the results of a very great amount of experimental work. A valuable and important paper. 14,000 w. Bulletin de la Société d'Encouragement—Oct., 1898. No. 24174 G.

Some Physical Properties of Ceramic Pastes. (Sur Quelques Propriétés Physiques des Pates Céramiques.) M. Le Chatelier. Some valuable data, supplementing M. Coupeau's researches, giving measurements of the shrinkage, porosity, coefficients of elasticity, and tenacity of numerous pastes and glazes. 1800 w. Bulletin de la Société l'Encouragement—Oct., 1898. No. 24176 G.

Copper.

The Chemistry of Materials of Engineering—Copper. A. H. Sexton. Discusses the physical and chemical properties of the metal, the sources, metallurgy, &c. 2400 w. Prac Engr—Oct. 21, 1898. No. 23713 A.

Metalloids.

Metalloids in Castings. Malcolm McDowell. Read before the Western Foundrymen's Assn., at Chicago. Discusses the things that give value to pig iron, grading of foundry iron, &c., with discussion. 4000 w. Ir Trd Rev—Nov. 24, 1898. No. 24089.

Steel vs. Iron.

Steel for Axles, Crank Pins and Piston Rods. Editorial discussing the increasing use of steel, the care needed in the preparation of specifications, the treatment of steel in the drop, &c. 800 w. Am Eng & R R Jour—Nov., 1898. No. 23752 C.

Test Bars.

Method of Casting Test Bars for the A. F. A. Testing Committee. Thomas D. West. Read before the Pittsburg Foundrymen's Assn. An illustrated description of the writer's method which has proved most successful. 3500 w. Ir Trd Rev—Nov. 24, 1898. No. 24088.

Testing.

Mechanical Testing of Materials. W. Gadsby Peet. From a paper read before the Inst of Mech. Engs. (Eng.) at the Oct. meeting. Describes the system adopted by the Midland Railway at Derby. Ill. 2000 w. Col Guard—Nov. 4, 1898. No. 23940 A.

POWER AND TRANSMISSION.

Belting.

Notes on Belting. G. R. MacLeod. Describes various kinds of belting in use and gives tests of leather, rubber, cotton and other belts. 3500 w. Can Elec News—Nov., 1898. No. 23931.

The Variation of Belt Tensions with Power Transmitted. William S. Aldrich. The purpose of the paper is to open a discussion on questions relating to belt tensions. Gives the writer's conclusions drawn from experiments. 2000 w. Trans of Am Soc of Mech Engs, No. 802—Nov., 1898. No. 24245 D.

Commercial Buildings.

The Mechanical Plant of a Modern Commercial Building. William H. Bryan. A discussion of the mechanical, steam, and electrical plants of such buildings. Ill. 15,800 w. Trans of Am Soc of Mech Engs, No. 801—Nov., 1898. No. 24242 D.

Compressed Air.

Economics in the Use of Compressed Air. R. P. Whitelaw. Read before the Mech. Engs'. Assn. of S. Africa. Presents the advantages of compressed air over other sources of power in deep mining, with suggestions for use. 3800 w. Mod Mach—Nov., 1898. No. 23832.

Compressors.

A Compound Duplex Automatic Air Compressor and the Largest Impulse Water Wheel in the World. E. A. Rix. Discusses the difficulties and usual methods of overcoming them, describes the ideal compressor, and the writer's method of constructing and operating compressed air engines. Ill. 3200 w. Am Mach—Nov. 10, 1898. No. 23900.

Power Cost.

The Cost of the Long Distance Electric Transmission of Large Powers. (Die Kosten der Elektrischen Uebertragung Grosser Kräfte auf Weite Entfernungen.) A discussion based on the data obtained from the power plant at Rheinfelden and applied to the proposed plant at Heimbach. 2500 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1898. No. 24110 D.

SPECIAL MOTORS.

Diesel Engine.

Progress of the Diesel Oil Engine. An account of the progress made by this interesting engine and the results achieved. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23942 A.

Gas Engines.

Cheap Fuel Gas in Boston and the Future of the Gas Engine. An editorial review of the industrial changes caused by the distribution of cheap fuel gas. 900 w. Eng Rec—Nov. 12, 1898. No. 23919.

STEAM ENGINEERING.

Blowing Cylinders.

Smeaton and the First Use of Cast Iron Blowing Cylinders. Frank Firmstone. A review of the records and their probable correctness, concluding on the probable use between 1765 and 1768. 1400 w. Eng & Min Jour—Nov. 19, 1898. No. 24029.

Blowing Engine.

Compound Blowing Engine. (Verbund-Gebläsemaschine.) A. v. Jhering Illustrated description of powerful horizontal compound blowing engine for the Hernadthal iron works at Krompach, Hungary. Corliss valve gear is used on both steam and air cylinders. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Oct. 15, 1898. No. 24100 D.

Compound Blowing Engine Built for the Hernadthaler iron works, Krompach, Hungary. Translated from the *Zeitschrift des Vereines Deutscher Ingenieure.* Illustrates and describes an interesting horizontal blast-furnace blowing engine built in Bohemia 800 w. Eng News—Nov. 10. 1898 No 23889.

Boiler Explosion.

A Dynamite Boiler Explosion. An account of an explosion where the results seem to indicate the use of dynamite or its equivalent. An illustrated description. 1200 w. Locomotive—Oct., 1898. No. 23765.

The Birmingham Boiler Explosion. An illustrated description of the explosion on the premises of the Birmingham, Ala , Ice Factory Co., with discussion of the possible causes 1400 w. Ice & Refrig—Nov., 1898. No. 23777 C.

The Sharlston Colliery Boiler Explosion. Illustrations and particulars of the explosion that took place at this colliery last July. 800 w. Ir & Coal Trds Rev—Nov. 4, 1898. No. 23952 A.

Boilers.

Improvements in Steam-Boilers, and the Brick Settings of Same. William Barnet Le Van. Illustrated detailed description of an improved boiler of the horizontal-flue class, and the requisites of a proper boiler setting. Considers the production of smoke to be due often to improper setting. 6000 w. Trans of Am Soc of Mech Engs, No 792—Nov., 1898. No. 24234 D.

Influence of Presence of Air upon the Efficiency of Boilers. (Influence des Rentrées d'air sur le rendement des Chaudières) Abstract of

a paper by M. Compère at the Congrès des Ingénieurs en chef, with discussion. 1000 w. Le Génie Civil—Oct. 15, 1898. No. 24154 D.

Boiler Trials.

Report of the Committee on the Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam-Boiler Trials. Submits a revised code. The changes are mainly in the line of amendments shown by experience to be desirable. 15,000 w. Trans of Am Soc of Mech Engs, No. 805—Nov., 1898. No. 24245 D.

Combustion.

A New Process of Combustion. Paul J. Schlicht. An explanation of the writer's process with illustrated description of the invention. 3300 w. Jour Fr Inst—Nov., 1898. No. 23827 D.

Condensing Plant.

Cooling Tower and Condenser Installation. J. H. Vail. States the existing conditions previous to the installation, describes the plant in detail, and reports the advantage derived. 2000 w. Trans of Am Soc of Mech Engs., No. 804—Nov., 1898. No. 24244 D.

Cylinder Compression.

Experiments upon the Economy of Cylinder Compression in Condensing and Non-Condensing Engines. (Expériences faites, Sans et Avec Condensation, sur l'Economie de la Compression dans l'Espace Mort.) V. Dwelshauvers-Dery. A long illustrated article with many tables of test data. The conclusion drawn is that, for either form of engine, each point of cut-off has a corresponding best degree of compression. 12,000 w. Rev Universelle de Mines—Oct., 1898. No. 24184 G.

Cylinders.

Lagging Small Engine Cylinders. F. H. Illustrates and describes the work. 2500 w. Mech Wld—Nov. 11, 1898. No. 24037 A.

Dow Engine.

The Dow Engine. (Corliss Foundation.) Josiah Dow. An illustrated description of the writer's engine, an outgrowth of the Corliss, with a statement of the advantages secured. 6800 w. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23984 C.

Draft.

Draft-Appliances—Ash Pans. F. P. Roesch. Deductions based on a series of experiements extending over a period of ten years, with different engines and coals. 800 w. Loc Engng—Nov., 1898. Serial. 1st part. No. 23779 C.

Engine Design.

American Engine Design from an English Standpoint. Charles Day. A letter calling attention to one or two points where the writer thinks American engine-builders might take a hint from English practice. Ill. 900 w. St Ry Jour—Nov., 1898. No. 23757 D.

Proper Proportional Parts of Engines. A topical discussion by Messrs. Vail, Schumann, Dow, Christie, and Schermerhorn. 4200. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23983 C.

Expansion Governor.

Combined Engine and Dynamo. An illustrated description of an engine recently erected at the headquarters of the Metropolitan Fire Brigade (London) and forming a part of the electric light plant, especially describing a new form of governor. 1100 w. Engr, Lond—Nov. 4, 1898. No. 23948 A.

Feed Pump.

Economy Test of a Unique Form of Feed Pump. F. Meriam Wheeler. Data and results of test of vertical compound feed pump intended for use as a marine auxiliary of a less wasteful type than now generally in use. 2500 w. 2 plates. Trans Soc N A & M E.—1898. No. 24252 F.

Governor.

The Dow Chronometric Governor. Josiah Dow. Describes and illustrates the invention, explaining its action. 3500 w. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23985 C.

Indicators.

Methods of Testing Indicators. D. S. Jacobus. Describes in detail the methods used at Stevens Institute of Technology, for the purpose of soliciting a discussion. Ill. 2800 w. Trans of Am Soc of Mech Engs, No. 799—Nov., 1898. No. 24241 D.

Regulations.

The New Saxon Regulations for the Prevention of Accidents with Water-Tube Boilers. Ch. Bellens. Translated from *La Revue Technique.* The regulations promulgated by the Technical Commission appointed by the province of Saxony, and put into effect Dec. 18, 1897. 2000 w. Power—Nov., 1898. No. 23788.

Smoke.

The Reduction of the Smoke Nuisance in Locomotive and Other Boilers. (Verminderung der Rauchplage bei Lokomotiv und Anderen Kesselfeuerungen.) A paper read before the German Railway Society with especial reference to the Langer and Marcotty steam-jet system for improving combustion in locomotive boilers. 6000 w. Glaser's Annalen—Nov. 1, 1898. No. 24120 D.

Steam Dynamo.

Three-Thousand Horse Power Direct-Driven Steam Dynamo at the Station of the Edison Company, Brooklyn, N. Y. Illustrated detailed description of features deserving special mention. 1500 w. Power—Nov., 1898. No. 23787.

Steam-Engine Practice.

Some Points in Modern Steam-Engine Practice. Henry Hodgson. Abstract of paper read before the Manchester (Eng.) Assn. of Engs. Gives the writer's views as to the best type of steam-engine for general use, discussing details. 2500 w. Eng's Gaz—Nov., 1898. No. 23874 A.

Steam Generation.

The Generation and Utilization of Steam by the Lykens Valley Coal Company and Summit

Branch Coal Company, Dauphin County, Pa. R. Van A. Norris. Report of investigations made for the purpose of discovering and remedying a large discrepancy in the amount of coal used for firing at two collieries. Illustrations, maps, and tables are given. 5000 w. Trans of Am Soc of Mech Engs, No. 796—Nov., 1898. No. 24238 D.

Steam Pipes.

Experiments on the Flow of Steam Through Pipes. R. C. Carpenter. Describes experiments made to determine the coefficient of friction of steam flowing at different velocities through pipes and fittings. 3800 w. Trans of Am Soc of Mech Engs., No. 806—Nov., 1898. No. 24246 D.

Valve Diagram.

Bilgram's Diagram and the Solution of Problems Involving Lead. Merrill Van G. Smith. Showing that one of the fundamental problems involving lead, cited in Prof. Fox's recent article on the Zeuner Diagram, can be solved by a simple and exact construction quite as simple as by the Zeuner diagram. 500 w. Jour Fr Inst—Nov., 1898. No. 23828 D.

Valve Gear.

Valve Gear of the Willans Engine. John Svenson. Comments on the characteristics of this gear and a statement of its leading advantages. Ill. 1800 w. Trans of Am Soc of Mech Engs, No. 797—Nov., 1898. No. 24239 D.

Winding Engines.

Safety Appliances for Winding Engines. States the requirements common to all safety appliances, and describes the chief appliances in use, including the Römer, Baumann, Müller, Hahn (Münzner), and Jetschim apparatus, comparing the systems and giving conclusions. Ill. 5000 w. Col. Guard—Nov. 11, 1898. No. 24053 A.

MISCELLANY.

Address.

American Society of Mechanical Engineers—Annual Address of the President, 1898. C. W. Hunt. A discussion of engineering practice, industrial progress, and the work of an engineer, with its effect on mind, character and life. 5400 w. Trans of Am Soc of Mech Engs, No. 807—Nov., 1898. No. 24247 D.

Brewery.

The New Castillo Hermanos Brewery in Guatemala. (Neue Brauerei von Castillo Hermanos in Guatemala). C. W. Schüitz. Description and plans of large brewery plant designed in Germany for erection in Guatemala, and representing the latest German practice. 1800 w. Zeitschr d Ver Deutscher Ing—Oct. 29, 1898. No. 24108 D.

Graphical Methods.

Graphical Methods for the Reduction of Experimental Observations. W. F. Durand. Brief discussion of some of the ways in which results may be treated, calling attention to the methods most readily applicable. 1800 w. Sib Jour of Engng—Nov., 1898. No. 23988 C.

The Application of Graphic Interpolation in Machine Design. Adolph S. Ostreicher. Describes a method showing how tables can be directly completed without involving the design of each size individually nor sacrificing correctness. Ill. 1100 w. Engr, Lond—Oct. 28, 1898. No. 23867 A.

Inventors.

The Beneficent Inventor. An editorial on the progress due to the inventor, and the blessings conferred on humanity, and the essentials of success. 3000 w. Engng—Oct. 28, 1898. No. 23860 A.

Liquefied Gases.

The Liquefaction of Gases. Raymond Jerry, in *Revue Encyclopédie Larousse*. A review of the researches in this field, and the most recent results. Ill. 4000 w. Sci Am Sup—Nov. 19, 1898. No. 23977.

Moment of Inertia.

The Theory of the Moment of Inertia. C. V. Kerr. States the fundamental ideas underlying the theory, gives a comparison of results from analytical and graphical methods for the purpose of showing the correctness of the methods used, and the salient features of this form of the theory. 5000 w. Trans of Am Soc of Mech Engs, No. 793—Nov., 1898. No. 24235 D.

Type-Setting.

The Cox Type-Setting Machine. Illustrated detailed description. 1100 w. Engng—Nov. 18, 1898. No. 24273 A.

MILITARY ENGINEERING.

American Ordnance.

American Naval Ordnance and Armor in the Late War. The report of Capt. Charles O'Neill shows the number of vessels supplied with munitions of war, and that most of the material came from the United States. Other related matters are noted. 900 w. Eng News—Nov. 10, 1898. No. 23886.

Armor Plate.

Cammell's Krupp Process Plate. Illustrated account of the trials of this plate at Shoeburyness, and recording another success in the manufacture of thick Krupp process armor. 1500 w. Engr, Lond—Nov. 11, 1898. No. 24063 A.

Krupp Armor—Its Application to Defeat Shell Fire in Warships. A discussion of recent makes of Krupp armor, the alterations that have been made in applying armor to vessels, and some things learned from the Santiago fight. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23944 A.

Test of a Bethlehem-Krupp Armor Plate. Official report of tests recently made at the Redington proving grounds, with results. 500 w. Ir Age—Nov. 24, 1898. No. 24098.

Battleships.

American-Built Warships for the Russian Navy. Illustrations of the vessels, with details of their construction and equipment. 1700 w. Sci Am—Nov. 5, 1898. No. 23763.

The French Battleship "Charles Martel." Some particulars of this vessel, with general view, and two-page plate of a section of her main engines. 300 w. Engng—Oct. 28, 1898. No. 23859 A.

Launch of the First-Class Battleship Formidable. Describes the vessel and its equipment, giving special illustrations showing various features. 2000 w. Engng, Lond—Nov. 18, 1898. No. 24270 A.

Launch of the Japanese Battleship Shikishima. Illustration and description of the vessel and its equipment and a brief account of the launching. 2000 w. Engr, Lond—Nov. 4, 1898. No. 23951 A.

The French Battleship Bouvet. An illustrated description of the largest and finest iron-clad at present in the French navy. 900 w. Engr, Lond—Nov. 4, 1898. No. 23947 A.

Boats.

The Standard Navy Boats. Arthur B. Cassidy. A very fully illustrated account of the standard small boats for the United States Navy, including ships boats, steam cutters, and dinghies. 3000 w. 38 plates. Trans Soc N A & M E—1898. No. 24250 F.

Cruiser.

Electrical Equipment of the U. S. Cruiser "Newark." E. W. Countiss. An illustrated description of the electric plant recently installed. 2800 w. Am Elect'n—Nov., 1898. No. 23739.

H. M. S. Diadem. Illustrated description with dimensions and particulars of the vessel, equipment and armament. 2500 w. Engr, Lond—Oct. 28, 1898. No. 23869 A.

H. M. S. Hyacinth. Describes the twin-screw, wood-sheathed, steel protected cruiser just launched 1200 w. Engr, Lond—Oct. 28, 1898. No. 23871 A.

H. M. S. Pactolus. Particulars and report of preliminary trials, just successfully completed. 1500 w. Engr, Lond—Oct. 28, 1898. No. 23870 A.

Destroyers.

Torpedo Boat Destroyers for the United States Navy. Illustrated description of the vessels of this class ordered for the U. S. navy, with particulars of the engines, and criticisms of the designs. 3500 w. Engr, Lond—Oct. 21, 1898. No. 23723 A.

Torpedo-Boat Destroyers. G. W. Dickie. A paper presented before the Society of Naval Architects and Marine Engineers, giving detailed description of a torpedo-boat destroyer, designed with especial reference to the conditions which prevail on the Pacific coast of the United States. 2500 w. 1 plate. Trans Soc N A & M E—1898. No. 24249 F.

Explosives.

High Explosives and Smokeless Powders and their Applications in Warfare. Hudson Maxim. Reviews the attempts made to produce smokeless powder, the success with small arms, the importance of a smokeless cannon powder, and the production of the Maxim-Schüpphaus powder. 5000 w. Jour Fr Inst—Nov., 1898. Serial. 1st part. No. 23829 D.

The Manufacture of Explosive Compounds. Perry F. Nursey. Part first discusses gunpowder and gun-cotton and describes the methods of manufacture. 2000 w. Ind & Ir—Nov. 4, 1898. Serial. 1st part. No. 23937 A.

Fireproofing.

The Fireproofing of Wood for the New United States Battleships. A description of the method of preparation, with information concerning the actual fireproofness, durability and strength. Ill. 2200 w. Eng News—Nov. 17, 1898. No. 24001.

Flash Signals.

Long Distance Signals from Free or Captive Balloons. (Les Signaux à Grandes Distances à Bord des Aérostats Captifs ou Libres.) M. Dibos. A system of flash signals based upon the use of phosphine generated from calcic phosphide. The details are carefully worked out and illustrated. 2600 w. La Rev Tech—Nov. 10, 1898. No. 24172 D.

Gunboats.

Construction of the New U. S. Composite Gunboats with a Comparison of Their Performances. Illustrations, dimensions, particulars, and trials. 1500 w. Marine Engng—Nov., 1898. No. 23834 C.

New British gunboats "Dwarf" and "Thistle." Describes boats of an interesting type, designed with special reference to the requirements on river service in distant British possessions. 1000 w. Engng—Oct. 28, 1898. No. 23862 A.

Guns.

The New High Powered Guns of the Vickers, Sons & Maxim Company. An illustrated description of the gun, giving an explanation of the device for preventing erosion and stating the advantages of the new mechanism. 1800 w. Sci Am—Nov. 5, 1898. No. 23764.

H. M. S. Diadem.

Boilers and Engines of H. M. S. Diadem. Engraving of engines and drawings showing most of the fittings of the boilers, with brief description. 500 w. Engr, Lond—Nov. 11, 1898. No. 24065 A.

Monitors.

The Proposed New Monitors. Illustrated description of the designs now rejected, of the harbor defense vessels ordered by Congress. To be followed by the amended designs. 1300 w. Sci Am—Nov. 12. 1898. No. 23892.

Naval Evolutions.

Use of Curves of Space and Velocity in Evolutions. (Impiego delle Curve degli Spazi e delle Velocità nei Cambiamenti di Distanze o d'Intervalli e nelle Evoluzioni in Generale.) G. Como. The author argues for the closer study of graphical methods in the Italian navy. 7000 w. 2 plates. Rivista Marittima—Aug-Sept., 1898. No. 24192 H.

Naval Operations.

Official Report on the Naval Operations in the West Indies. A chronological abstract of Secretary Long's report of Sampson's fleet, which describes the naval operations before Cuba which ended in the destruction of Cervera's fleet. Chart. 7800 w. Sci Am Sup—Nov. 12, 1898. No. 23896.

Navies.

The Navies of the World. An article on the British navy, dealing with the battleships and armored cruisers. The first of a series on the subject named. Ill. 3000 w. Sci Am—Nov. 26, 1898. Serial. 1st part. No. 24084.

Rifle.

The Springfield Rifle. D. W. Flagler. An interesting discussion from the annual report of the Chief of Ordnance, concerning the relative merits of the Springfield rifle and the magazine gun. 1500 w. Ir Age—Nov. 24, 1898. No. 24099.

Torpedo Boats.

Department Plans for Torpedo Boats and Destroyers for the U. S. Navy, Recently Contracted For Gives the essential elements of design stipulated, with plans of engines, and list of contracts let. 3000 w. Marine Engng—Nov., 1898. No. 23835 C.

War Ships.

Designs of the New Vessels for the U. S. Navy. Philip Hichborn. A full description of the new vessels for the U. S. Navy, including battleships, monitors, torpedo-boats and destroyers, with tables of data and many large folding plates giving the full drawings of the vessels. A most important paper. 5000 w. 27 large plates. Trans Soc N A & M E—1898. No. 24255 H.

Yachts.

The Steam Yacht as a Naval Auxiliary. W. P. Stephens. A paper before the Society of Naval Architects and Marine Engineers, giving a very complete account of the composition and performance of the auxiliary fleet of steam yachts in the U. S. navy during the Spanish war. 4500 w. 9 plates. Trans Soc N A & M E—1898. No. 24254 F.

MINING AND METALLURGY.

COAL AND COKE.

American Coal.

See Economics and Industry, Commerce.

Arkansas.

The Bonanza Arkansas Coal Mines. H. Foster Bain. Notes gathered during a recent visit. A semi-anthracite coal of high steaming value. The means of working are described 1500 w. Eng & Min Jour—Nov. 12, 1898. No. 23910.

Bavaria.

The Development of the Coal Fields of Upper Bavaria. (Das Oberbayrische Kohlenvorkommen und Seine Ausbeute.) L. Hertle. A discussion of the geological conditions and practical workings of the coal fields of upper Bavaria, with data of the industrial and commercial results. 4500 w. 1 plate. Glückauf—Oct. 29, 1898. No. 24134 B.

California.

Tesla Coal Mines. F. J. Horsewill. A large coal property in Alameda Co., California, which has recently been developed. Particulars as to its location, the position of the seams, the methods employed in working them and the plant for preparing and handling the coal. Ill. 3300 w. Mines & Min—Nov., 1898. No. 23743 C.

Coal Dust.

Methods of Dealing with Coal Dust. Discusses the methods used at the various stages of the work, and all the points of importance in connection with the work. Ill. 3300 w. Col Guard—Oct. 21, 1898. No. 23727 A.

Coal Industry.

See Economics and Industry, Commerce and Trade.

Continental Europe.

The Coal and Coke Industries of Continental Europe. Part first begins the review of these industries in Germany. 900 w. Ir & Coal Trds Rev—Oct. 21, 1898. Serial. 1st part. No. 23725 A.

Preparation.

Improvements in Preparation. (Neuerungen in der Aufbereitungen.) V. Waltl. Describing and illustrating recent improvements in machines for washing and preparing coal. 1500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 22, 1898. No. 24132 B.

Novelties in Coal-Preparing Machinery. V. Waltl in *Oesterreichische Zeitschrift für Berg- und Huttenwesen.* Illustrated description of washers and draining grid. 1200 w. Col Guard—Oct. 28, 1898. No. 23866 A.

Subsidence.

Subsidence Caused by Colliery Workings. Joseph Dickinson. A discussion of this paper, read at the June meeting of the Manchester (Eng.) Geological Society. 2200 w. Col Guard—Nov. 11, 1898. No. 24057 A.

Subsidence Caused by Colliery Workings. Joseph Dickinson. Read before the Manchester (Eng.) Geological Soc. Explains the methods for computing the extent of subsidence, the areas for support, and other details of the subject. 3200 w. Col Guard—Oct. 28, 1898. No. 23864 A.

Survey.

Geological Survey of South Wales and Monmouthshire. A. Strahan. Read before the British Assn., at the Bristol meeting. An explanation of the work and the revision of the coal fields. 2500 w. Col Guard—Nov. 4, 1898. No. 23939 A.

Weathered Coals.

The Calorific Power of Weathered Coals. R. S. Hale and Henry J. Williams. Tabulated

results of analyses with statement of the conditions. The results show a slight diminution of calorific power directly traceable to weathering. 900 w. Trans of Am Soc of Mech Eng, No. 798—Nov., 1898. No. 24240 D.

Wedge.

A New Wedge Process as a Substitute for Explosives. (Eine Neue Keilvorrichtung zum Ersatze der Schiessarbeit.) Describing the use of a combined screw and wedge tool for use in breaking down coal in mines in which explosives cannot be permitted. 1000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 5, 1898. No. 24133 B.

New Wedge for Coal-Getting. From *Oesterreichische Zeitschrift für Berg- und Hüttenwesen.* Describes an improved wedge and its manner of working. Ill. 900 w. Col Guard—Nov. 11, 1898 No. 24055 A.

COPPER.

Lake Superior.

The Boom in Lake Copper Mining. Brief account of the great activity in this industry. The mines of the lake country are valued at $105,000,000. 1200 w. Ir Age—Nov. 24, 1898. No. 24097.

Manufacture.

The Converter in Copper Manufacture. P. L. Barthe, in the *Annales des Mines.* Illustrates and describes an apparatus devised by Paul David, called the "selecteur," and its working. 1800 w. Ir & Coal Trds Rev—Nov. 11, 1898. No. 24061 A.

Ore Deposits.

The Occurrence of Copper and Lead in the San Andreas and Caballo Mountains. C. L. Herrick. Describes the region and the conditions prevailing. 2500 w. Am Geol—Nov., 1898. No. 23907 D.

Refining.

See Electrical Engineering, Electro-chemistry.

Smelting.

Copper-Matte Smelting in Chili. Henry Watson. Some information concerning the furnaces of Panulcillo. 800 w. Aust Min Stand—Oct. 6, 1898. No. 23880 B.

Wyoming.

The Wyoming Copper Region. J. C. Kennedy. Describes this deposit, its location, development, and various mines. Ill. 1700 w. Eng Rec—Nov. 26, 1898. No. 24228.

GOLD AND SILVER.

Alaska.

Mining Conditions in Alaska. "Alex. Quartz." Discussing the seeming decline of the mining industry and explaining some of the causes. Claims that it is not from lack of gold in its mines, but the hard conditions imposed by the government. Gives encouraging reports of some districts recently explored. 2500 w. Min & Sci Pr—Nov. 12, 1898. No. 23999.

Alluvial Deposits.

The Glacial Epoch.—Its Relation to Alluvial Gold Deposits. L. O. Beal. Reviews the evidence of glaciation, and gives his own opinion in explanation of the ice movement. Illustrates the means by which alluvial gold was gathered and re-distributed, and other geological work. Ill. 3500 w. Aust Min Stand—Oct. 20, 1898. Serial. 1st part. No. 24071 B.

Amalgamating.

Notes on a Laboratory Amalgamating Device and Comparisons with Actual Mill Results. H. A. Guess. Illustrates the device, explaining the necessities that led to its adoption and outlining the method used in determining the milling value. 1100 w. Can Min Rev—Oct. 31, 1898. No. 23767 B.

Arizona.

Mining in Yavapai County, Arizona. John F. Blandy. Some notes on the development work of this field. 900 w. Eng & Min Jour—Nov. 5, 1898. No. 23803.

Coolgardie.

The Coolgardie Contract. Relating to the project for furnishing a water-supply to this gold-mining district in western Australia. The way it is proposed to solve a difficult problem. 2000 w. Ir & Coal Trds Rev—Nov. 4, 1898. No. 23954 A.

Cyanide.

Discrepancies in Slime Treatment. Discussion and correspondence on the paper of W. A. Caldecott. 4300 w. Jour of Chem & Met Soc of S. Africa—Sept., 1898. No. 22846 E.

Loss of Gold in Cyaniding by Volatilization. Matt. W. Alderson. An account of the writer's work and his investigations of the effect of oxygen in connection with the dissolution of the gold by cyanide. 3500 w. Min & Sci Pr—Oct. 29, 1898. No. 23789.

Dredging.

Dredging for Gold. J. B. Jaquet. Official report of the industry in Otago, N. Z. Ill. 2500 w. Aust Min Stand—Sept. 22, 1898. Serial. 1st part. No. 23879 B.

Klondike.

The Cost of Production of Gold and the Klondike Fields. Discussing whether the cost of obtaining the gold is not greater than the profit. 2300 w. Bankers' Mag, Lond—Nov., 1898. No. 23849 C.

New Zealand.

Gold Mines in the New Zealand West Coast Districts. (Mines d'Or de la Nouvelle-Zélande, District de la Côte Ouest.) Illustrated description of the district, its geology, and principal mines. 4400 w. Le Génie Civil—Oct. 22, 1898. No. 24155 D.

Treatment of Gold Ores in the Hauraki Peninsula, New Zealand. A. H. Bromly. Describes some typical plants ot this district, and gives general information. 2500 w. Eng & Min Jour—Nov. 12, 1898. No. 23909.

River Deposits.

The Buried Rivers of California as a Source of Gold. J. R. Scupham. How these rich and peculiar formations have been preserved. Modern instances of similar volcanic action

covering river beds. Some particulars in regard to the returns which have been made by drifting on the ancient bed rock. 4000 w. Mines & Min—Nov., 1898. No. 23745 C.

Russia.

The Present Conditions of Gold Mining in the Kochkara Region in the Oural. R. Helmhacker. Part first is mainly descriptive of the geological features. 1500 w. Min & Sci Pr—Nov. 5, 1898. Serial. 1st part. No. 23992.

Utah.

The Chloride Point Mine, Utah. Description, with illustration, of this silver mine, which was pronounced worthless, but by methods of handling the low-grade ores, has proved of value. 1200 w. Eng & Min Jour—Nov. 19, 1898. No. 24027.

Tintic, Utah.

The Mines of Tintic, Utah. Don Maguire. The largest and one of the most productive silver, lead and copper regions in the state. A description of the situations of the various mines, the formations in which they are found, the extent of their development and the amount of their production. 3500 w. Mines & Min—Nov., 1898—No. 23747 C.

Transvaal.

The Transvaal Fields. Report of increasing yield but decreasing prosperity, with extracts from published articles, giving comments on reports, expenses, &c. 1200 w. Aust Min Stand—Sept. 22, 1898. No. 23878 B.

Washington.

The Republic Mine, Washington. M. H. Joseph. An illustrated description of this first mine of a promising district. 1600 w. Eng & Min Jour—Nov. 5, 1898. No. 23802.

IRON AND STEEL.

American Iron.

See Economics and Industry, Commerce and Trade.

Iron and Steel.

See Economics and Industry, Commerce and Trade.

Iron Ore.

Iron Ore and Pig Iron Production in 1897. Statistics for the United Kingdom compiled from the General Report on Mines and Quarries. 1300 w. Col Guard—Nov. 18, 1898. No. 24280 A.

Prospecting.

Magnetic Methods of Prospecting for Iron Ores in Sweden. From a report on the mining industry of Sweden, 1897, by Prof. Nordenstrøm, describing the instruments employed and the methods of using them. Ill. 2800 w. Mines & Min—Nov., 1898. No. 23744 C.

Sheet Iron.

Note on the Manufacture of Sheet Iron. (Note sur la Fabrication des Toles). Hubert Bya. This paper is limited to the discussion of sheets more than 2½ millimetres thick. The processes are fully described and numerous figures are given. The article is an interesting and valuable review of the present state of sheet metal manufacture on the continent of Europe. One plate, 8000 w. Rev Universelle des Mines—Sept., 1898. No. 24179 G.

Steel.

Influence of Arsenic upon the Mechanical Properties of Steel. (Etude sur l'Influence de l'Arsenic sur les Propriétés Mécaniques de l'Acier.) J. Marchal. The conclusion is drawn from the results of numerous experiments, that the small percentages of arsenic met with in steel have practically no effect upon its working qualities. 1400 w. Bulletin de la Société d'Encouragement—Oct., 1898. No. 24177 G.

MINING.

Explosives.

High-Pressure Steam as a Substitute for Explosives in Coal Mines. H. Schaw. Abstract of a paper taken as read at the Birmingham meeting of the Inst. of Min. Engs. Suggests that a cartridge of pure water, lodged in a shothole be converted into steam by means of electricity. 700 w. Col. Guard—Oct. 21, 1898. No. 23729 A.

Firedamp.

Firedamp Disengagements and Barometric Variations. Herr Bellmann, in *Glückauf*. Abstract translation. A report of observations recorded, and particulars of explosions 1400 w. Col Guard—Oct. 21, 1898. No. 23828 A.

Haulage.

Haulage in Mines. Llewellyn M. Evans. Essay awarded second prize in contest. A comparison of the methods of underground haulage used in the anthracite mines of Pennsylvania. 3300 w. Mines & Min—Nov., 1898. No. 23748 C.

Head Frames.

Steel Head Frame for the Philadelphia & Reading Coal & Iron Co.'s Mines at Gilberton, Pa. W. L. Cowles. Illustrated description of the most recent practice in this line. 800 w. Eng News—Nov. 10, 1898. No. 23884.

Lamps.

The Sussman Mine Lamp. (Note sur la Lampe de Mines du Système Sussman.) Ad. Abrassart. Illustrated description of the ingenious dry accumulator of Sussman and its application to various systems of mine lamps, also of the mechanism used in charging large numbers of these lamps at once. 4000 w. Rev Universelle des Mines—Sept., 1898. No. 24181 G.

Mine Transmission.

See Electrical Engineering, Transmission.

New South Wales.

The Mining Industries of New South Wales. An account of the various minerals and metals found, and the value of the deposits. 1400 w. Jour Soc of Arts—Oct. 28, 1898. No. 23816 A.

Pumping.

A Mammoth Electric Pumping Plant. Illustrates and describes the largest electrical pump-

ing plant in the United Kingdom—at the Gorebridge Collieries. 1700 w. Col Guard—Nov. 4, 1898. No. 23953 A.

Details of Deep Well Pumps—Geological Conditions in England. W. H Booth. Showing how English practice differs from American, and the conditions affecting it 1200 w. Am Mach—Nov. 24, 1898. No. 24095.

Hydraulic and Electrical Pumps for Mines. Translated Abstract from *Glückauf*. Illustrates and describes these types. 1700 w Ir & Coal Trds Rev—Oct. 21, 1898. No. 23726 A.

Pumping-Station at Sierra Almagrera. Gustave Charles Reinhold. Contributed to the Inst. of Civ. Engs. (England). This line of hills is in South-east Spain, and reaches a height of 3000 ft. above sea level. Describes the scheme of the various mining companies for the drainage of this region, giving illustrations of the work. 5700 w. Col Guard—Nov 11, 1898. No. 24059 A.

Respiratory Apparatus.

New Respiratory Apparatus for Use in Mines. From *Le Génie Civil*. Gives a brief description of the Fleuss apparatus, and describes two new types recently adopted in Austria-Hungary. Ill. 2300 w. Sci Am Sup—Nov. 19, 1898. No. 23976.

Road Curve.

A Mine Road Curve. George W. Engel. Describes an interesting device by which much time and expense are saved and capacity for hoisting coal increased. Ill 900 w. Mines & Min—Nov., 1898 No. 23746 C.

Safety Catches.

Bley Safety Arrangements for Mine Cages. Illustrates and describes the safety apparatus adopted at the collieries of Florentin, Kaestner & Co., Reinsdorf, near Zwickau, Saxony, giving tabulated results of five trials carried out in the testing frame, or tower. 1800 w. Col Guard—Nov. 4, 1898. No. 23938 A.

Safety Stop for the Briart Guide. (Parachute pour Guidonnage Briart.) Ch. Marbais. Illustrated description of a simple safety stop for mine cages or other hoistways where the Briart rail guides are used. 1000 w. Rev Universelle des Mines—Sept., 1898. No. 24180 G.

Timbering.

The Stability of Certain Woods for Mine Timbering. C. Dütting. From a paper read before the Munich Mining Congress. An account of investigations to establish the value of beech props, to ascertain the suitability of acacia wood, and to determine whether preservative substances can be employed with advantage. 4000 w. Col Guard—Oct. 28, 1898. No. 23863 A.

Tunnelling.

Tunnelling by Cross Cut and on the Vein in Metal Mines. Arthur Lakes. Discussing its advantages and uncertainties. Circumstances where a cross-cut should not be run and where it may be profitable, and some notable instances of each. Ill. 3000 w. Mines & Min—Nov., 1898. No. 23749 C.

Tunneling on the Mother Lode. W. C. Ralston. Description of work and report of cost of tunneling by the Melones Mining Co. in the Mother Lode in Calaveras Co , Cal., with comparison of cost of tunneling at the Hogsback mine in Placer Co., Cal. Ill. 1800 w. Min & Sci Pr—Nov. 5, 1898. No. 23993.

Ventilation.

Determination of a Fan's Efficiency by Guibal's Conception of the Temperament. Gustave Hanarte. From a communication to the Société des Ingenieurs du Hainaut. Gives methods for ascertaining the useful work given out by a fan, which in the author's opinion permit the testing of the various types. Ill. 3300 w. Col Guard—Nov. 18, 1898. No. 24281 A.

Testing Ventilators with the Aid of an Opening to Free Air. (L'Essai des Ventilateurs à l'Aide d'un Guichet à l'Air Libre.) S. Hanappe. A long analytical discussion of the whole subject of the movement of air in mine galleries and the finding of the equivalent orifice for a given mine section. 10,000 w. Rev Universelle des Mines—Oct., 1898. No. 24183 G.

The Useful Work of Mine Fans and Method of Observing It. Gustave Hanarte, in a communication to the Société des Ingenieurs du Hainaut Describes the trial at the mine and the conditions. 2800 w. Col Guard—Nov. 11, 1898. No 24056 A.

Water.

Observations on the Sudden Influx of Water from Large Springs. (Beobachtungen Eigenthümlicher Auftriebserscheinungen der Wasser Grösserer Quellengebiete) F. W. Klönne. With especial reference to the influx of water into the mines at Dux, Bohemia, from adjacent springs. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 15, 1898. No. 24131 B.

Winding Engines.

See Mechanical Engineering, Steam Engineering.

MISCELLANY.

Belgium.

Belgian Mineral Statistics for 1897. Emile Hargé. Report of the Directeur-Général des Mines. 2000 w. Col Guard—Oct. 21, 1898. No. 23730 A.

China.

British Mineral Concessions in China. A résumé of the meeting of the Pekin Syndicate held in London, with other statements in regard to the Shansi concessions. 1800 w. Col Guard—Nov. 18, 1898. No. 24277 A.

Diamond Mines.

The Kimberly Diamond Mines. (Note sur l'Exploitation des Mines de Diamants à Kimberly.) Albert Bordeaux. Treats of the geology of the region, describes the principal mines, method of extracting and treating the rock, and gives a table of diamond production for eight years. 2 plates. 7000 w. Rev Universelle des Mines—Sept., 1898. No. 24178 G.

Graphite.

The Graphite Deposits of Passau. (Ueber die Graphitlagerställen der Umgebung von Passau.) E. Weinschenk. An illustrated account

of the important Bavarian graphite deposits near Passau and Silberberg. 2000 w. 1 plate. Glückauf—Nov. 5, 1898. No. 24135 B.

Lead.

A Proposed New Method of Smelting Lead Concentrates. Henry F. Collins. Outlines a process which he calls a roast-reaction process. 2500 w. Can Min Rev—Oct. 31. 1898. No. 23768 B.

Manganese.

The Manganese Ores of Brazil. (Les Manganéses du Brésil.) Miguel Ribeiro Lisboa. A very full account of the location of these ores, their composition, method of mining, and exploitation. 9000 w. 1 plate. Rev Universelle des Mines—Oct., 1898. No. 24182 G.

Metallurgy.

See Electrical Engineering, Electro-chemistry.

Nickel.

The Extraction of Nickel from Its Ores by the Mond Process. Prof. Roberts-Austen. Abstract of paper read at meeting of the Inst. of Civ. Engs. (England). Describes the experiments which led to this method, and the satisfactory results. 1100 w. Col Guard—Nov. 11, 1898. No. 24058 A.

The Mining, Smelting and Refining of Nickel. Titus Ulke. A detailed account of a variety of processes in use in various places, giving data of costand with special reference to the electrolytic refining method and the saving of valuable by-products. 2500 w. Engineering Magazine—Dec., 1898. No. 24291 B.

Onyx.

The Onyx-Marbles. Courtenay De Kalb. An explanation of the term, the requisite qualities, preparation and cost, localities where deposits are found and other information. 3800 w. Stone—Nov., 1898. No. 24013 C.

Ore Deposits.

Ore Deposits Near Coolac, New South Wales. Describes a district presenting interesting features in connection with its ore deposits. 1300 w. Aust Min Stand—Oct. 6, 1898. No. 23881 B.

Petroleum.

The Illuminating Value of Russian Petroleum. Dr. M. Albrecht's defense of Russian petroleum, in reply to an unfriendly article published in Hamburg. 1300 w. Am Mfrs & Ir Wld—Nov. 4, 1898. No. 23837.

Precious Stones.

How to Identify Precious Stones. Leopold Claremont. Abstract of article in the London *Mining World* Reviews the various tests usually applied, advising that the prospector be guided by the result of all, as a single test is apt to mislead. 1400 w. Eng & Min Jour—Nov. 19, 1898. No. 24028.

Salt.

The Manufacture of Salt Briquettes at the Royal Salt Works at Salzkammergut. (Ueber Sudsalzbriquettirung bei den k. k. Salinen des Salzkammergutes.) Max v. Arbe-ser. With illustrations of the hydraulic presses, and detailed description of the process. 6000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 28, 1898. No. 24117 B.

Soda Deposits.

Occurrence and Treatment of the Carbonate of Soda Deposits of the Great Basin. S. A. Knapp. Information concerning these extensive deposits in the western United States, and their increasing economic importance. 2000 w. Min & Sci Pr—Nov. 5, 1898. No. 23994.

Surfusion.

Surfusion in Metals and Alloys. W. C. Roberts-Austen. Abstract of a paper read at the Royal Society, May 26, 1898. Reviews the results of investigations from this point, and experiments made, and gives the method adopted by the author which gives evidence as to the identity of the behavior of saline solutions and metallic alloys as regards selective surfusion. 900 w. Nature—Oct. 27, 1898. No. 23819 A.

Turkey.

The Useful Minerals of Turkey. R. Helmhacker. Reports the country rich in mineral wealth although the production is small. Gold, silver, copper, lead, antimony, arsenic, sulphur, chrome ore, manganese, iron, emery, salt, soda, coal &c., are found. 3300 w. Eng & Min Jour—Nov. 26, 1898. No. 24227.

United Kingdom.

The Output, Value and Distribution of Coal in 1897. Statistics and detailed particulars relating to the distribution of coal, compiled from the General Report on Mines and Quarries. Map. 1800 w. Col Guard—Nov. 18, 1898. No. 24276 A.

Uranium.

Uranium. A. Selwyn Brown. Relates the discovery of this mineral, giving such information as has been obtained, and some of the uses to which it is applied. 1500 w. Aust Min Stand—Oct. 20, 1898. No. 24072 B.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Acetylene.

Automatic Feed Acetylene Generator. (Appareils Cousin à Chute Automatique de Carbure.) Illustrated description of an acetylene generator which feeds the carbide automatically. 500 w. La Rev Tech—Oct. 25, 1898. No. 24169 D.

The Acetylene Installation for Lighting the City of Wabash, Ind. Brief account of a plant that is to replace the artificial gas system. The gas is piped through the streets and sold by meter, and is thus far a success. 1000 w. Am Gas Lgt Jour—Nov. 28, 1898. No. 24263.

The Present Position of Acetylene Lighting. Abstract translation of a lecture by Dr. Paul Wolff of Berlin, published in *Zeitschrift für Angewandte Chemie.* Part first considers cost

of production, the difficulties to overcome, cause of explosions, &c. 2500 w. Jour Gas Lgt—Nov. 8, 1898. Serial. 1st part. No. 23998 A.

Birmingham, Eng.

The Extension Scheme of the Saltley Gas-Works, Birmingham, Eng. An account of the work now in progress and the further extensions to be made. 3000 w. Jour Gas Lgt—Oct. 18, 1898. No. 23710 A.

Burner.

The Self-Mixing Gas Burner. Particulars and engravings from *Revue Industrielle*. Describes the new apparatus of M. L. Denayrouze. 1600 w. Sci Am Sup—Nov. 26, 1898. No. 24086.

Combustion.

Combustion in Retort Furnaces. Otto Pfeiffer. Abstract translation from the *Journal für Gasbeleuchtung*. Describes observations made, giving results. Ill. 2000 w. Jour Gas Lgt—Nov. 1, 1898. No. 23877 A.

Gas Undertakings.

The Purchase of Gas Undertakings. Frank Balfour Browne. Notes the tendency to pass to municipal bodies the undertakings that have gained success through private capital, and discusses questions which were raised in connection with the Morley case in England. 2500 w. Jour Gas Lgt—Nov. 8, 1898. No 23997 A.

Illuminating Power.

The Loss of Illuminating Power of 25- to 30-Candle Gas when Mixed with Air. E. G. Love. Read at Oct. meeting of the Am. Gas Lgt. Assn. Calls attention to a few points in connection with the deleterious action of air on coal-gas. Discussion. 2800 w. Pro Age—Nov. 1, 1898. No. 23769.

Leakages.

Localizing Leakages. W. Binse Randall. Read at meeting of the So. Dist. Assn. of Gas Engs. and Managers. Describes a method found to be economical and satisfactory. 2000 w. Gas Wld—Nov. 12, 1898. No. 24049 A.

Leeds, England.

Inclined Retorts at Leeds. An account of a visit of inspection to the gas-works, and the opening of the new retort-house. 3500 w. Gas Wld—Oct. 22, 1898. No. 23712 A.

The Development and Extension of the Leeds Gas Undertaking. An account of a municipal gas undertaking whose policy has been rewarded by marked success, the extension of the works, new inclosed retort house, &c. 4000 w. Jour Gas Lgt—Oct. 25, 1898. No. 23850 A.

Light Extinctions.

Sudden Extinctions of Artificial Light. Norton H. Humphreys. Notes on what may be done in the way of guarding against failures, and the value of a safety bye-pass governor in gas distributing plants. 2300 w. Jour Gas Lgt—Nov. 15, 1898. No. 24091 A.

Longton, England.

New Gas-Producing Plant at Longton, Eng. Description of new works with plan. 1500 w. Jour of Gas Lgt—Oct. 25, 1898. No. 23851 A.

Mains.

Notes on Mains and Main Laying. Walton Forstall. Read at meeting of Am. Gas Lgt. Assn. Discusses weight of pipe, methods of connecting and laying, special work, &c., giving an appendix and discussion. Ill. 10,500 w. Am Gas Lgt Jour—Nov. 14, 1898. No. 23963.

Naphthalene.

Extended Experience with the Hastings Carburation Process for the Prevention of Naphthalene Deposits in the Distributing Mains and Services. Charles E. Botley. Read at meeting of the So. Dist. Assn. of Gas Engs. and Managers, England. A brief description of the process, with report of extended experience. Also discussion. 6300 w. Gas Wld—Nov. 12, 1898. No. 24048 A

Prepayment Meters.

Slot Cookers and All About Them. E. W. T. Richmond. Shows the penny-in-the-slot device to have been known before the Christian era, briefly considers the modern applications, and sketches the history of the prepayment system in connection with automatic meters and the growth of gas-cookers in this connection. Ill. 3600 w. Jour Gas Lgt—Nov. 15, 1898. Serial. 1st part. No. 24090 A

Use of Gas.

How Can We Make the Use of Gas More Universal? A discussion of the paper of Henry L. Doherty at the Niagara meeting of the Am. Gas Lgt. Assn. 6500 w. Am Gas Lgt Jour—Nov. 7, 1898. No. 23845.

Water-Gas Setting.

Depth of Fire in a Water-Gas Set. J. M. Rusby. General consideration of the subject with report of special tests, and discussion. 2800 w. Pro Age—Nov. 15, 1898. No. 23966.

SEWERAGE.

Sewage Disposal.

Sewage Disposal at Chorley, England. Illustrated description of a plant using ferozone precipitation and polarite filters. 1000 w. Eng Rec—Nov. 26, 1898. No. 24222.

The Biolysis of Sewage. Describes the theory of the Scott-Moncrief cultivation tanks and the new apparatus to replace filters in purifying the effluent. 1500 w. Eng Rec—Nov. 26, 1898. No. 24223.

Sewage Pump.

An Automatic Sewage Lift, Salem, N. J. An illustrated description of plant operated by water from street mains. 700 w. Eng Rec—Nov. 5, 1898. No. 23796.

Sewer Flushing.

The Effect of Flushing Devices for Small Sewers. Illustrated description of valuable experiments in Washington. 2500 w. Eng Rec—Nov. 12, 1898. No. 23924.

Sewer Flushing. Review of new method, by J. H. Fuertes, for determining the flushing power of discharges of different volumes in sewers of different grades. 1000 w. Eng Rec—Nov. 26, 1898. No. 24214.

Ventilation.

The Ventilation of Sewers and Drains as a Source of Diphtheria. James Aitken. Extracts from experts showing that when sanitary improvements have caused a decrease of ordinary diseases, they have frequently been accompanied by an increase of diphtheria. Ill. 1400 w. San Rec—Oct. 28, 1898. No. 23818 A.

STREETS AND PAVEMENTS.

Asphalt.

The Manufacture of Asphalt Pavements. A statement of the method of producing hard or soft pavements by changes in the process of manufacture. 1100 w. Eng Rec—Nov. 19, 1898. No. 24015

Denver, Colo.

Notes on the Sewers and Pavements of Denver, Colo. A description of comparatively recent work. 700 w. Eng News—Nov. 10, 1898. No. 23885.

London Streets.

Inaugural Address of J. Wolfe Barry. Discusses London traffic with reference to the proposed and suggested new streets and improvements. Map. 10,000 w. Jour Soc of Arts—Nov. 18, 1898. No. 24272 A.

London Streets and the Traffic. Editorial discussion of the address of J. Wolfe Barry. 1500 w. Engng—Nov. 18, 1898. No. 24274 A.

Paving.

A Study of Paving Materials. An analysis of the value of different pavements, by G. W. Tillson, made by representing an ideal pavement as having 100 per cent. of value and ascribing to each property of such a pavement a certain percentage of influence. The relative merits of each actual paving material expressed in the same manner, enable its advantages for any given street to be discussed. 3500 w. Eng Rec—Nov. 26, 1898. No. 24224.

WATER SUPPLY.

Cincinnati, O.

The California Pump Pit, Cincinnati Water-Works. Illustrated description of a circular caisson, 129 ft. in diameter, 20 ft. high, and 12¼ ft. thick in the roof. 900 w. Eng Rec—Nov. 12, 1898. No. 23922.

Cisterns.

Tank and Cistern Construction. Information intended to facilitate the designing of tanks and cisterns suitable for the positions they are to occupy. Considers the strains they are subject to, leakage, &c. 3300 w. Builder—Nov. 5, 1898. No. 23960 A.

Filtration.

Filtration and the Water Supply of Cities and Towns. Deductions drawn from investigations made at various places to determine whether the methods applied to large water plants, afford the desired protection. 1300 w. Sci Am—Nov. 12, 1898. No. 23891.

Grafton, W. Va.

The Grafton, W. Va., Water-Works. Illustrated description of a plant stated to represent standard practice for small works. 600 w. Eng Rec—Nov. 19, 1898. No. 24022.

Ground-Water.

The Level of Ground-Water Supply. (Grundwasserspiegel bei Brunnenanlagen.) Dr. P. Forchheimer. An elaborate mathematical discussion of the variations in the level of ground water, when the source is drawn from wells for water supply. Two articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 4, 11, 1898. No. 24118 each B.

Philadelphia.

Politics and Engineering in Philadelphia. A report of the attacks on the Chief of the Bureau of Water made in the interests of private water companies. 800 w. Eng Rec—Nov. 5, 1898. No. 23795.

Pumping-Engine.

Triple-Expansion Pumping Engine at Ogdensburg, N. Y. Charles A. Hague. An illustrated detailed description of a low-duty triple-expansion engine recently installed in the water-works of the city named, and representing the most advanced practice of this type. 2000 w. Eng News—Nov. 24, 1898. No. 24200.

Purification.

Chemical Purification of Potable Water. From *La Nature.* Describes the method recently proposed by Prof. Lapeyrere that permits of effecting nearly absolute sterilization. The process has been utilized in the manufacture of a small pocket-filter by MM. Delsol & Fillard. 1500 w. Sci Am Sup—Nov. 19, 1898. No. 23978.

Lessons From the Louisville Experiments on Water Purification. Editorial on the value of experimental work, the careful investigations of mechanical filters at Louisville, and similar work at other places. 2800 w. Eng News—Nov. 10, 1898. No. 23887.

Reservoirs.

Special Features of the Reservoirs at the Cambridge, Mass., Water-Works. Illustrates and describes the overflow and aerating chambers of the Hobbs Brook reservoir, and the gate-house, and asphalt lining of the Payson Park reservoir. 600 w. Eng News—Nov. 24, 1898. No. 24201.

San Francisco.

San Francisco Water Supply. Illustrates and describes the municipal system of artificial storage, giving explanation of the climatic and other conditions prevailing. 1800 w. Sci Am—Nov. 19, 1898. No. 23974.

Submerged Main.

Ellis Island Submerged Water Main. Description of a 5,100 ft. main 6 ins. in diameter laid in New York harbor. 1300 w. Eng Rec—Nov. 26, 1898. No. 24221.

Tonawanda, N. Y.

The North Tonawanda, N. Y., Water-Works. T. W. Barrally. Illustrated description of a new plant with an unusual protective intake pier, riveted steel intake, and about 16 miles of wood distributing mains. 2200 w. Eng Rec—Nov. 12, 1898. No. 23923.

Water-Meters.

Popular Errors About Water-Meters. John C. Trautwine, Jr. Statements correcting popular errors in regard to the object sought by using meters, giving quoted correspondence from various cities and towns showing their value in checking waste. Ill. 2800 w. Pro of Engs Club of Phila, No. 67—Nov., 1898. No. 23-986 C.

Water Rates.

The Basis of Water Rates. Review of decision of the California Supreme Court based on a recent decision of the U. S. Supreme Court, as to the method of computing fair water rates to be charged by a local company. 1100 w. Eng Rec—Nov. 5, 1898. No. 23793.

The Chillicothe Water Rates Case. Review of a decision of the Missouri Supreme Court as to the meaning of a schedule of meter rates in a charter of a private water company. 1400 w. Eng Rec—Nov. 19, 1898. No. 24017.

MISCELLANY.

Convention.

The Convention of the American Society of Municipal Improvements. An account of the meeting with abstracts of papers on sewers, pavements, street extensions, electrolysis, &c. 6000 w. Eng Rec—Nov. 5, 1898. No. 23799.

Disinfecting.

Disinfecting Stations. Reviews a recent book by Samuel Rideal, giving brief abstract of chapter on the subject named. 1400 w. Builder —Nov. 12, 1898. No. 24042 A.

Drainage.

Modern Drainage Inspection and Sanitary Surveys. Gerard J. G. Jensen. Part first gives a brief illustrated description of some of the most reliable apparatus for making tests for hidden defects with the mode of application. 600 w. San Rec—Nov. 18, 1898. Serial. 1st part. No. 24271 A.

Fire Protection.

The Fire Protection Apparatus at the Charlottenburg Exhibition. (Die Feuerwehrtechnischen Maschinen auf der Ausstellung in Charlottenburg) Wilh. Geutsch. Devoted especially to aerial ladders and similar apparatus for the use of municipal fire departments. Serial. Part 1. 3000 w. Zeitschr d Ver Deutscher Ing —Oct. 29, 1898. No. 24109 D.

Rubbish.

The Removal of House Rubbish. (Die Beseitigung des Hausmülls.) An account of the Kinsbruner system in which the closed bodies of the collecting carts are made removable for the better delivery of the rubbish to the barges. 1200 w. Gesundheits-Ingenieur—Oct. 31, 1898. No. 24128 B.

Sanitation.

The Reconstruction of Plague-Stricken Cities in India. A. J. Hughes. Presents the great importances of these problems, the difficulties, and an explanation of the character of the enterprises now in progress for dealing with this subject. 6300 w. Engr, Lond—Nov. 11, 1898. No. 24062 A.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in September. Detailed list with classified summary. 4300 w. R R Gaz—Nov. 4, 1898. No. 23784.

Comparative Travel.

Railway Travel in Europe and America. Benjamin H. Ridgely. Gives the conditions of travel on the continent of Europe, comparing with American accommodations, with illustrations of some of the car arrangements. 5800 w. Ry Age—Nov. 4, 1898. No. 23838.

Fast Runs.

A Remarkable Run on Great Western Railway. Charles Rous-Marten. Reports the particulars of a fast run on a British railway, at the average rate of 58.7 miles an hour. 1600 w. Engr, Lond—Nov. 4, 1898. No. 23943 A.

Fast Run on a French Railway (La Marche d'un Rapide au Chemin de Fer du Nord.) Description with diagram of speeds and profile of track between Paris and St. Quentin. The average speed was 62.7 miles per hour over a distance of 95 miles, the train weighing 178 tons. 1000 w. La Rev Tech—Nov. 10, 1898. No. 24171 D.

Fast Runs on the Wabash. Notes the changes recently brought about on this railroad, and gives records of runs, and particulars relating to them. 800 w. Ry Age—Nov. 11, 1898. No. 23928.

Freight Checking.

The "Vericheck" System of Checking and Loading Freight. Describes the system devised by Charles T. Banks, which has proved successful in active practice, giving a copy of the instructions. 2500 w. Ry & Engng Rev—Nov. 12, 1898. No. 23964.

Japan.

A Journey to the Tenth Annual Railway Congress of Japan. Willard C. Tyler. An interesting account of this journey, describing the equipment, customs, and railway management. 1800 w. Ry & Engng Rev—Nov. 26, 1898. Serial. 1st part. No. 24265.

Trains Breaking.

Trains Breaking in Two. The methods of investigating trains parting used on the Nashville, Chattanooga and St. Louis is explained. 1200 w. Ry Age—Nov. 18, 1898. No. 24035.

Wrecking.

Recovery of Two Locomotives from the River Adour. (Relevage de Deux Machines Tombées dans l'Adour, à Tarbes.) Interesting short illustrated description of method and tackle em-

ployed in the salvage of the locomotives. 400 w. Le Génie Civil—Oct. 15, 1898. No. 24153 D.

FINANCIAL.

Abandonment.

Abandonment of the Carbondale and Honesdale Gravity Railroad. Gives briefly the history of this road, one of the oldest in the world. Ill. 1500 w. R R Gaz—Nov. 18, 1898. No. 24007.

Auditing.

Duties of the Traveling Auditor. J. Shirley Eaton. Extracted from the *Railway Agent and Station Agent*. States briefly the personal qualities and preparation desirable, and considers the duties and manner of fulfilling them. 2400 w. Ry and Engng Rev—Oct. 29, 1898. No. 23742.

Bonding.

The Canadian Bonding Privilege. Condensed from an article in the *Toronto Globe*. Discusses the traffic through Canadian territory, and the comparative Canadian traffic through the United States, and the effect if the Canadian Pacific and the Grand Trunk should be placed under the Interstate Commerce Act. 1700 w. R R Gaz—Nov. 25, 1898 No. 24209.

British Railways.

British Railway Returns. Editorial on the Board of Trade return for the year ending Dec., 1897. The traffic is unprecedented both in volume and revenue. 1500 w. Engng—Oct. 21, 1898. No. 23732 A.

Earnings.

Net Railway Earnings for Nine Months. Report showing the tendencies of earnings of the various groups of roads as compared with corresponding periods. 1200 w. Bradstreet's—Nov. 19, 1898. No. 24026.

India.

The East Indian Railway Report for Latter Half of 1897. Comment and statistics based on the latest report of the Board of Directors of the East Indian Railway, which show a prosperous year in spite of the plague and famine. 800 w. Ind Engng—Oct. 1, 1898. No. 23821 D.

LEGAL.

Interstate Commerce.

The Interstate Commerce Commission's Demands for More Power. M. H. Smith. A discussion of the additional powers desired by the commission, as shown in the Cullom bill, claiming that not one will tend to correct the rate demoralization. 2500 w. R R Gaz—Nov. 18, 1898. No. 24005.

Smoke Nuisance.

Indictment of Railroad Companies for Nuisance. Editorial commenting on the recent indictment of the Long Island Railroad Co. for the smoke nuisance. 1300 w. R R Gaz—Nov. 11, 1898. No. 23906.

MOTIVE POWER AND EQUIPMENT.

Dump Car.

The Goodwin Dump Car. Illustrates and describes the most recent type of this car, used for handling and dumping material for railroad work. 800 w. Eng News—Nov. 17, 1898. No. 24000.

Dynamometer Car.

A New Dynamometer Car. Illustrated description of a car built by the C. C. C. & St. L. Ry. and equipped by the University of Illinois for the mutual advantage of both parties. 800 w. R R Gaz—Nov. 25, 1898. No. 24208.

Gondola Car.

Four-Wheeled Gondola Car, Delaware & Hudson Canal Co. Illustrates the construction of a car rapidly disappearing from use, but once the standard cars for the conveyance of coal. 800 w. R R Car Jour—Nov., 1898. No. 23913.

Locomotive Boiler.

See Mechanical Engineering, Machine Works and Foundries.

Locomotive Efficiency.

Locomotive Efficiency and Capacity. C. A. Scley. Discusses the advance in capacity, and how brought about, and the compound non-condensing principle as applied to locomotives. 1200 w. Loc Engng—Nov., 1898. Serial. 1st part. No. 23781 C.

Locomotives.

A Run on a Four-Cylinder Engine. Describes the performance of an English locomotive, known as No. 720. 1200 w. Engr, Lond—Nov. 4, 1898. No. 23949 A.

Compound Consolidation Pusher Engine; Lehigh Valley R. R. Illustrates and describes an engine with a guaranteed hauling capacity of a 1000 tons of train load behind the tender at an average speed of 17 miles per hour, on a mountain cut-off. 400 w. Eng News—Nov. 24, 1898. No. 24205.

Compound Express Passenger Locomotive for the Prussian State Railways. Two page plate and other engravings with dimensions. 250 w. Engng—Nov. 4, 1898 No. 23936 A.

Consolidation Locomotive—Chesapeake and Ohio Railway. A locomotive designed by W. S. Morris, for mountain service, is illustrated and described. 900 w. Ry Mas Mech—Nov., 1898. No. 23841.

Consolidation Locomotive for the Delaware & Hudson. Illustration and general dimensions of locomotive lately built by the Dickson Mfr. Co., of Scranton, Pa. 200 w. R R Gaz—Nov. 18, 1898. No. 24008.

Consolidation Locomotives for the Union Pacific. Illustration showing appearance, with a list of the principal dimensions of the simple locomotives. 450 w. R R Gaz—Nov. 18, 1898. No. 24010.

Experiments upon a Compound Express Locomotive. (Expériences Faites au Chemin de Fer du Nord sur une Locomotive Compound à Grande Vitesse.) F. Barbier. Discussion, with reproductions of indicator diagrams, of experiments lately made, with conclusions. 3000 w. Le Génie Civil—Oct. 15, 1898. No. 24-151 D.

Express Engine, Great Eastern Railway. Illustrates and describes a powerful type of express locomotives intended particularly for fast

seaside traffic. 150 w. Engr, Lond—Oct. 28, 1898. No. 23868 A.

Four Cylinder Express Locomotives. (Viercylindrige Schnellzugs-Lokomotiven.) Rolf Sanzin. A review of the various types of four cylinder engines which have been made since 1852, with a tabulated scheme of those which are at present in use. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 21, 1898. No. 24115 B.

Hayes' Ten-Wheel Locomotive. M. N. Forney. Illustrates and describes an engine built for the Baltimore & Ohio R. R. in the fifties. 1200 w. Am Eng & R R Jour—Nov., 1898. No. 23750 C.

Locomotive Design—The Working Stress of Materials. Francis J. Cole. The present article discusses piston rods. Ill. 1800 w. Am Eng & R R Jour—Nov., 1898. No. 23751 C.

New Locomotives for the South Eastern Railway, England. J. Pearson Pattinson. Principal dimensions with illustrated description. 500 w. R R Gaz—Nov. 4, 1898. No. 23785.

New Locomotive for Very High Speed. (Nouvelle Locomotive à Très Grande Vitesse.) F. Barbier. A criticism of the high-speed locomotive design of M. Thuile. 1700 w. Le Génie Civil—Nov. 5, 1898. No. 24162 D.

Recent Types of European and American Locomotives. A full page plate containing 63 designs, with description of each and general remarks on the tendency in America and Europe. 8000 w. Eng News—Nov. 10, 1898. No. 23888.

Results of Recent Practical Experience with Express Locomotive Engines. Walter M. Smith. Read before the Inst. of Mech. Engs. (England). Also editorial. An account of extensive experiments with the object of obtaining an idea of the fitness of five classes of engines to perform a given duty. 5800 w. Engr, Lond—Nov. 4, 1898. No. 23950 A.

Richmond Locomotives for Finland. Illustrated description of engines of foreign type built in the United States. 500 w. Loc Engng—Nov., 1898. No. 23780 C.

The Heilmann Electric Locomotive. Description of the electric locomotive presented five years ago, and also of the improved designs recently built. 1500 w. Eng News—Nov. 24, 1898. No. 24202.

The Largest Locomotive in the World. General description with illustrations of the locomotives for the Union railroad, connecting the works of the Carnegie Co. Also editorial discussion as to the value of monster locomotives. 3000 w. Engr, Lond—Nov. 11, 1898. No. 24064 A.

Tests on Four-Cylinder Locomotives. (Versuche mit Viercylindrigen Lokomotiven.) F. Leitzmann. A review of the tests on the high-speed four-cylinder compounds made by M. Barbier on the Northern Railway of France. Serial. Part 1. 5000 w. Zeitschr d Ver Deutschr Ing—Oct. 22, 1898. No. 24105 D.

The Two Heaviest Locomotives. Editorial comparison of the heaviest American locomotive with the heaviest locomotive in Europe. 700 w. R R Gaz—Nov. 25, 1898. No. 24211.

Private Train.

The French Presidential Train Built by the International Sleeping Car Company on the Occasion of the Czar's Visit to France. General description, with illustrations, and details of construction. 2000 w. R R Car Jour—Nov., 1898. No. 23911.

Repair Prices.

The Adjustment of Prices of Car Repairs. Editorial considering the difficulties of the problem. 1200 w. Am Eng & R R Jour—Nov., 1898. No. 23753 C.

Sleeping Car.

Canadian Pacific Sleeping Car. Plan, interior view, and description of very elaborate decoration, designed by a Parisian designer brought from France for the work. 1200 w. R R Car Jour—Nov., 1898. No. 23912.

Trucks.

Car Truck Construction and Repairs. J. C. Barber. Condensed from a paper presented at the Sept. meeting of the Northwest Ry. Club. Calls attention to features in which there is room for improvement, and discusses bolsters, center plates, bearings, etc. 1800 w. Eng News—Nov. 3, 1898. No. 23771.

NEW PROJECTS.

Alaska.

Railroad Building in Alaska. An illustrated account of the difficulties encountered. The present year will close with about 35 miles of road constructed. 1500 w. Ry Age—Nov. 11, 1898. No. 23929.

Chinese Railways.

The Pekin Hankau Railway Contract. The text of the contract recently made between the director-general of the Chinese railways and the Belgian syndicate, for the construction of a road from Lou kon-chiao to Hankau. 2000 w. U. S. Cons Repts—Nov., 1898. No. 23814 D.

See also Economics and Industry, Commerce and Trade.

Congo.

The Congo Railway. Editorial, describing the geographical character of the country, the difficulties met in surveying the road, some peculiarities of the construction, etc. 2000 w. Engng—Oct. 28, 1898. No. 23861 A.

Ealing.

The Ealing and South Harrow Railway. A brief account of a new line to be constructed in England. 900 w. Engr, Lond—Nov. 18, 1898. No. 24268 A.

Recent Construction.

The New Railway Construction of 1898. A general survey of the new work of the year, in the United States, showing it to be the largest since 1892. 2800 w. Eng News—Nov. 17, 1898. No. 24003.

Russia.

Railroads in Russia. Gives interesting statistics of the growth of the Russian railroad system, commenting on the interesting features. 1200 w. R R Gaz—Nov. 11, 1898. No. 23903.

PERMANENT WAY AND FIXTURES.

Bridge Renewing.

Rapid Bridge Renewing on the Rock Island. Illustrates the progress and describes the method followed in replacing the bridge across Squirrel Creek, Colorado. 1000 w. Ry & Engng Rev—Nov. 19, 1898. No. 24076.

Chicago.

Concrete Masonry in Chicago Track Elevation. Illustrates and describes what is probably the largest use of concrete work in railway engineering that has ever been attempted. 2800 w. Ry & Engng Rev—Nov. 19, 1898. No. 24075.

Crossings.

Highway Crossing Gates. Report of the committee of the Assn. of Ry. Supts. of Brdgs. and Bldgs. The merits and disadvantages of the types in common use are discussed. 2000 w. Ry Age—Nov. 4, 1898. No. 23839.

Instrument.

The Equilibristat. Don J. Whittemore. Describes an instrument for determining, while riding over the road, the difference of elevation between the opposite rails, whether the outer rail on curves is properly elevated, and also for other track work. Discussion and correspondence. Ill. 6500 w. Jour W Soc of Engs—Oct., 1898. No. 23914 D.

Interlocking Signals.

Study of Interlocking Mechanisms. (Etude sur les Enclenchements.) M. Descubes. A very elaborate illustrated study of the general subject of interlocking and an exposition of a method for determining secondary interlockings. A valuable paper. 14000 w. Rev Gen des Chemins de Fer—Nov., 1898. No. 24190 F.

Locating.

From Trade to Profession—Advances in American Railway Location. William G. Raymond. Part first is introductory to a series of papers whose purpose is to point out the advance in American railroad location to the dignity of a profession, and the fitness of American engineers for the work in China. 1200 w. R R Gaz—Nov. 25, 1898. No. 24206.

Paris.

Line from Courcelles to the Champ de Mars, Paris. Crossing of the Auteuil Line,—Construction of the Passy Tunnel. (Ligne de Courcelles au Champ de-Mars, à Paris. Traversée de la Ligne d'Auteuil.—Construction du Tunnel de Passy.) A. Dumas. Complete description of the work and methods employed. Elaborately illustrated. 4500 w. 1 large plate. Le Génie Civil—Oct. 29, 1898. No. 24158 D.

Rack Railways.

Swiss Rack Railways. (Les Chemins de Fer Suisses à Cremaillère.) Table giving data of all the rack railways in Switzerland, including permanent way, rolling stock and operation details, with short explanatory note. 1500 w. Le Génie Civil—Oct. 29, 1898. No. 24159 D.

Rails.

Further Studies on Steel for Rails. (Weitere Studien über Schienenstahl.) A very full investigation into the use of basic open-hearth steel for rails, with data and results of tests, microphotographs of etched sections, and diagrams of behavior in service. Serial. 1st part. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 4, 1898. No. 24119 B.

Shops.

New Shops of the C. H. & D. Railway. An illustrated description of the new car shops at Lima, Ohio. 800 w. Ry Mas Mech—Nov., 1898. No. 23842.

Signal.

The Payne Block and Train Order Signal. Describes and illustrates a signal that has been in operation for six months on the L. S. & M. S. Ry. 800 w. Ry & Engng Rev—Nov. 5, 1898. No. 23825.

Snow Fences.

Snow Fences in France. Illustrates and briefly describes the styles tried in different countries. 900 w. R R Gaz—Nov. 11, 1898. No. 23905.

Stations.

New Pennsylvania Passenger Station at Jersey City. Plan of the new building made necessary by the fire of last winter. 350 w. R R Gaz—Nov. 18, 1898. No. 24009.

New Railway Stations in Dresden. (Les Nouvelles Installations des Gares de Dresde.) Henry Martin. Elaborately illustrated and complete description of several new stations. 3500 w. Le Génie Civil—Nov. 12, 1898. No. 24185 D.

New Station of the Pennsylvania R. R. at Pittsburg, Pa. General plan and description of improvements about to be made at a cost of probably over $1,500,000. 900 w. Eng News—Nov. 17, 1898. No. 24004.

Terminal.

The Terminal Wharves at Ivry. (La Gare d'Eau d'Ivry.) Georges Leugny. Illustrated description of the terminus of the Orleans Railway at Ivry (France) with notes upon the franchise under which it is to be constructed. 2000 w. La Rev Tech—Oct. 25, 1898. No. 24168 D.

Track Elevation.

Track Elevation in Chicago. The first six papers of a series on this subject, giving illustrated descriptions of work on the C. & N. W. Ry., P. C. C. & St. L. Ry., I. C. Ry., C. M. & St. P. Ry., and C. B. & Q. Ry. 15,600 w. Jour W Soc of Engs—Oct., 1898. No. 23918 D.

Tunnel.

Through the Arlberg with Oil Fuel. Describes the arrangements made to guard against the dangers to the men employed on the trains, arising from fumes and smoke. The run from Landeck to Bludenz is described. 1700 w. Engr, Lond—Nov. 18, 1898. No. 24269 A.

TRAFFIC.

Fares.

Austrian Experience with Passenger Fares. From an account by P. F. Kupka, published in the Journal of the German Railroad Union.

Changes made and their effects are discussed. 2700 w. R R Gaz—Oct. 21, 1898. No. 23479.

Industrial Department.

The Industrial Department of the Seaboard Air Line. The Explanation of John T. Patrick, as to the object and present status of this work. 2000 w. R R Gaz—Nov. 11, 1898. No. 23904.

Joint Traffic.

The Gentlemen's Agreement—A Bit of History. An account of the beginning of the Joint Traffic Association, and its history. 1200 w. Ry Age—Nov. 11, 1898 No 23927.

Mail Carrying.

Cost of Carrying Mail on the Southern Pacific. Testimony brought out at the hearing in San Francisco, before the committee appointed to investigate the postal service. 1400 w. R R Gaz—Nov. 18, 1898. No. 24011.

Military Traffic.

Military Traffic on the Long Island Railroad. An account of the manner of meeting the sudden increase of passenger and freight service required by the establishment of a camp at Montauk. 2000 w. R R Gaz—Oct. 14, 1898. No. 23339

The War Work of the Long Island Railroad. An account of what was done to handle the troops at Camp Wikoff and Camp Black. 2200 w. Ry Age—Oct. 21, 1898. No. 23636.

Police.

A Railroad Police and Some of its Work. L. F. Loree. An address at meeting of the Railway Claim Agents. Gives an account of the trouble caused by people stealing rides, walking on track, and otherwise causing trouble to railroads, and of the police system maintained and its cost. 1800 w. R R Gaz—Oct. 14. 1898. No. 23342.

Pooling.

Different Views of Pooling. Editorial discussion of the differences in the positions of railroad traffic officers, commenting especially on the views of Milton H. Smith. 2000 w. R R Gaz—Nov. 25. 1898. No. 24212.

Regulated Pooling. H. T. Newcomb. An examination of the conditions which it is proposed to exact as consideration for permission to pool traffic. 2200 w. R R Gaz—Nov. 4, 1898. No. 23786.

Russia.

Freight Traffic on Russian Railroads. Some information concerning the amount of freight. 400 w. U. S. Cons Repts—Nov., 1898. No. 23813 D.

Sleeping Car Rates.

Sleeping-Car Rates in America and Europe. Benjamin H. Ridgely. An interesting article giving a comparison of arrangements and rates in the United States and Europe, with related information. Ill. 6000 w. Ry Age—Oct. 28, 1898. No. 23704.

STREET AND ELECTRIC TRAMWAYS.

Berlin.

Combination Trolley and Conduit Electric Tramway at Berlin. (Tramway Électrique de Berlin à prise de Courant Tantôt Aérienne, Tantôt Souterraine.) Henry Martin. Full detailed illustrated description of the tramway and construction methods 2000 w. Le Génie Civil. —Nov. 5, 1898. No. 24161 D.

The Berlin Electric Railway. (Die Elektrische Stadtbahn in Berlin.) A general illustrated account of the new local electric railway in Berlin, showing both the elevated and underground construction. Two articles, 3500 w. Schweizerische Bauzeitung—Oct., 22, 29, 1898. No. 24129 each B.

Checking Employes.

System of Collection of Fares and Checking Employés. A. F. Walter. Describes a system that has given satisfaction on the Allentown & Lehigh Valley Traction Co. 3200 w. St Ry Rev—Nov. 15, 1898. No. 24031 C.

Comparative Costs.

Comparative Costs and Profits of Cable, Electric and Horse Railway Operation in New York City. A transcript of the private cost sheets and other records of the Metropolitan Street Railway Co. giving a true comparison of the relative cost of operation of cable, electric, and horse railways. A very important paper. 3500 w. St Ry Jour—Nov., 1898. No. 23759 D.

Conduit Systems.

Electric Conduit Systems. W. L. Hedenberg. Reviews the various systems that have been tried, commenting on the degree of success attained and illustrating the types, and giving a brief account of the extensive construction of the N. Y. Metropolitan St. Ry. Co. 2700 w. Elec, N. Y.—Nov. 23, 1898. No. 24087.

Convention.

Tenth Convention of the International Street Railway Association. E. A. Ziffer. An account of the meeting in Aug., 1898, at Geneva, Switzerland. Gives brief description of Geneva, its tramways, and the proceedings of the convention. Ill. 7000 w. St Ry Jour—Nov., 1898. No. 23758 D.

Cripple Creek.

Interurban Railroading at Cripple Creek. Illustrated detailed description of this three-phase system with current generated at high pressure, transmitted, reduced and converted. 1000 w. St Ry Jour—Nov., 1898. No. 23755 D.

Electric Locomotive.

The Paris-Lyons Mediterranean Co.'s High Speed Electric Locomotive. (Locomotive Electrique à Grande Vitesse de la Compagnie Paris-Lyon-Méditerranée.) M. Auvert. A very complete and elaborately illustrated description of the machine and account of tests. For the trials current was obtained from a large battery of accumulators hauled in a special car, but a conductor system will be used. All the levers and switches are handled by a compressed-air aux-

iliary system. 8000 w. Rev Gen des Chemins de Fer—Nov., 1898. No. 24189 F.

Electrical Survey.

An Electrical Survey in the Borough of Manhattan, New York City. A. A. Knudson. Investigations and facts showing results of stray current measurements between electric railways, underground pipes, etc., also results of tests on the Brooklyn Bridge, Ill. 5500 w. Trans Am Inst of Elec Engs—Oct., 1898. No. 24077 D.

English Systems.

English Electric Railroads. The first of a series of articles discussing recent developments. The present paper considers the Glasgow electric tramways. 1200 w. R R Gaz—Nov. 25, 1898. Serial. 1st part. No. 24213.

Honolulu.

Honolulu and Its Street Railways. Frank X. Cicott. An illustrated description of the tramways with brief reference to the general conditions of the place. 1400 w. St Ry Jour—Nov., 1898. No. 23760 D.

Ireland.

Irish Light Railways. Gives a map showing the positions of the various lines and summarizes the experience obtained from light railway construction in Ireland. 1600 w. Ry Wld—Nov. 10, 1898. No. 24044 A.

London.

The Central London Railway. Part first considers the route taken and some of the construction work, giving plans, maps, &c., and general remarks on the enterprise. 2000 w. Engr, Lond—Nov. 4, 1898. Serial. 1st part. No. 23946 A.

Mechanical Motors.

Application of Mechanical Motors to Tramway Traction. (Application des Moteurs Mécaniques à la Traction des Tramways.) Abstract of M. Ziffer's report on the subject to the Union Internationale des Tramways. It discusses all sorts of motors, electric, gas, steam, cables, compressed air, etc., with conclusions. 2800 w. Le Génie Civil—Oct 22, 1898. No. 24157 D.

Mountain Railway.

Mount Dore Electrically Driven Cable Railway. (Funiculaire du Mont Dore. Transport de Force par Courant Triphasé.) Illustrated detailed description of an interesting mountain railway in France. The cars are operated by a cable operated by an electric motor, power being derived from a neighboring waterfall. A large plate of detail drawings accompanies the article. 4000 w. La Rev Tech—Nov. 10, 1898. No. 24170 D.

New Zealand.

Possibilities for Electric Traction in New Zealand. Frank X. Cicott. Illustrates and describes the physical features of the islands, giving information of the intelligence of the people, the commercial importance, exports, and other matters of interest. 1400 w. St Ry Rev—Nov. 15, 1898. No. 24030 C.

Paris.

Preliminary Work on the Metropolitan (Underground) Railway, Paris. (Le Métropolitain de Paris. Travaux préparatoires en Cours d'exécution.) Description of methods of work, especially in the rearrangement of sewers, etc. Illustrations and one plate. 3500 w. Le Génie Civil—Oct. 22, 1898. No. 24156 D.

Philadelphia.

Organization and Operating Methods of the Union Traction Company of Philadelphia. An illustrated description of the plan of organization, power stations, distribution circuits, roadbed, rolling stock, etc. 5800 w. St Ry Jour—Nov., 1898. No. 23754 D.

Power Stations.

See Elect. Engineering, Generating Stations.

Special Cars.

Special Cars in Brooklyn, N. Y. Illustrates and describes some novel cars used on the Nassau Electric Railway, including an office car, tower car, two parlor cars, and a new type of convertible car. 1800 w. St Ry Jour—Nov., 1898. No. 23756 D.

Steel Ties.

Steel Tie Construction at Rochester, N. Y. Illustrates and describes a track construction in which old steel rails were used for ties. 500 w. St Ry Rev—Nov. 15, 1898. No. 24032 C.

Traction.

Mechanical Tramway Traction. Part first discusses the report of J. Allen Baker to the London county council, on this subject, and considers briefly the gas-power tram car. 1700 w. Jour of Gas Lgt—Nov. 1, 1898. Serial. 1st part. No. 23876 A.

Polyphase Traction. Editorial discussion of the relative merits of the competing systems, their disturbance effects, and engineering or economic value. 1500 w. Elect'n, Lond—Oct. 28, 1898. No. 24248 A.

Tramway.

Anderson's Tramway. An illustrated detailed description of this system as shown in the experimental line built at Leeds, Eng. 1300 w. Elec Eng, Lond—Nov. 4, 1898. No. 23958 A.

Cable versus Electric Traction in Newcastle. Important estimates prepared by W. N. Colam and Dr. John Hopkinson on the cost of installing and working cable and electric tramways in Newcastle. 10,000 w. Ry Wld—Nov. 10, 1898. No. 24047 A.

Electric Tramways of Monaco. Illustrates and describes this surface-contact system of electric traction, with the location and equipment. 2000 w. Ry Wld—Nov. 10, 1898. No. 24043 A.

Liverpool Corporation Electric Tramways. Illustrates and describes the new double bogie cars and their equipment. 1800 w. Ry Wld—Nov. 10, 1898. No. 24046 A.

Permanent International Tramway Union. (Union Internationale Permanents des Tramways.) Brief account of the meeting of this association at Geneva, and conclusions reached after discussion of several points of interest concerning electric traction. 1500 w. L'Electricien—Nov. 12, 1898. No. 24188 B.

NEW CATALOGUES AND TRADE PUBLICATIONS

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Baldwin Locomotive Works, Burnham, Williams & Co., Philadelphia, Pa., U. S. A.=Record of Recent Construction, No. 8. Specifications and illustrations of simple and compound locomotives recently constructed for use in China, Colombia, Chile, Peru, Russia, and various parts of the United States and Canada.

Baxter D. Whitney, Winchendon, Mass., U. S. A.=Illustrated catalogue of special woodworking machinery, including surface planing machines, wood scraping machines, sawing, boring, and moulding machines, also gauge lathes and special chair-making machinery. A remarkably beautiful specimen of typography, engraving, and press work.

The Hoppes Manufacturing Co., Springfield, Ohio, U. S. A.=Catalogue of steam separators, oil eliminators, and exhaust and live-steam feed-water heaters, with illustrated descriptions, specifications, and prices.

J. A. Fay & Co., Cincinnati, Ohio, U. S. A.= Sheet folder of American wood working tools of every kind, showing the capacity of the concern for the complete equipment of wood working establishments.

The Jeffrey Mfg. Co., Columbus, Ohio, U. S. A. =Descriptive catalogue of the Jeffrey Columbian combined separator, bolter, and screen for bolting and screening cement.

Merrill Pneumatic Pump Co., Bound Brook, N. J., U. S. A. = Pamphlet catalogue describing the Merrill pneumatic pumping machinery for excavating liquids by use of compressed air, using a displacement pump operating without floats. A pneumatic differential piston pump is also illustrated and described.

Pneumatic Engineering Co., New York. = Pamphlet describing at length the Harris system of pumping by compressed air, operating without floats and acting by the direct pressure of the air upon the surfaee of the liquid. Applications to mine pumping, fire service, and water supply are shown.

The Standard Time Stamp Co., New York.= Catalogue of the standard automatic time stamp for recording the exact time of any transaction; with long list of testimonials from users in a great variety of trades.

B. F. Sturtevant Co., Jamaica Plains, Mass., U. S. A.=Neat little pamphlet describing and illustrating the removal of the chimney at the works of the manufacturers and the successful substitution therefor of the Sturtevant system of mechanical draft.

Hyatt Roller Bearing Company, Harrison, N. J., U. S. A.=Catalogue and price list of Hyatt flexible roller bearing, showing numerous applications, together with tables of dimensions of hangers and floor stands; also data of tests, and letters of commendation from users.

Felt & Tarrant Mfg. Co., Chicago, Ill., U. S. A.=Pamphlet catalogues (*a*) describing and illustrating the construction and operation of the comptometer, a mechanical computing machine; (*b*) showing the applicability of the comptometer to railroad accounting, with practical examples, and a list of testimonials from railroad men.

Westinghouse Machine Company, Pittsburg, Pa., U. S. A.=Beautifully illustrated catalogue of Westinghouse compound engine, with data of tests and description of details.

American Impulse Wheel Co., New York.= Descriptive catalogue of the "Cazin" impulse water wheel with illustrations of details and tables for weir measurements, heads, pressures and power.

The Globe Company, Cincinnati, Ohio, U.S.A. =Very complete catalogue of filing cabinets and business furniture, including the Globe Wernicke systems of filing correspondence, documents and records; also supplies for indexing and cataloguing by the card-index method.

William Oxley & Co., Tudor Works, Pendleton, Manchester, England.=Illustrated price-list of storage tanks plant and appliances for oils, varnish, and chemical manufacturers.

S. A. Daniell, Ltd., Edward street, Parade, Birmingham, England.=Price-list of engineers', gas and fitters stocks and dies, twist drills, braces, tube cutters and vices. Dimensions and usual particulars given.

Jessop & Appelby Bros., Ltd., 22 Walbrook, London.=Fully coded catalogue, entitled "Appelby's Illustrated Hand-book of Hoisting Machinery," with nearly 200 illustrations of all types of hoisting machinery, giving prices and very clear descriptive matter.

Rose, Downs & Thompson, Ltd., Old Foundry, Hull, England.=Catalogue of oil-mill machinery and grain-warehouse machinery; also of filter presses and hydraulic presses, disintegrators, and pumps. Fully coded, illustrated, and dimensioned.

A. & P. W. McOnie, Cessnock Engine Works, Glasgow, Scotland.=Handsomely-illustrated catalogue of sugar-cane crushing, evaporating, and refining machinery; also of rice and coffee machinery. Telegraphic code.

D. Stewart & Co., Ltd., London Road Iron Works, Glasgow, Scotland.=Illustrated catalogues (*a*) of electrical machinery, dynamos, arc lamps and electric light fittings; (*b*) of textile machinery for printing or bleaching works; (*c*) of engine and boilers; (*d*) of "Theisen's" evaporative condenser feed purifier and heater, with description of working.